WIRE

OCTOBER 1940

AND WIRE PRODUCTS

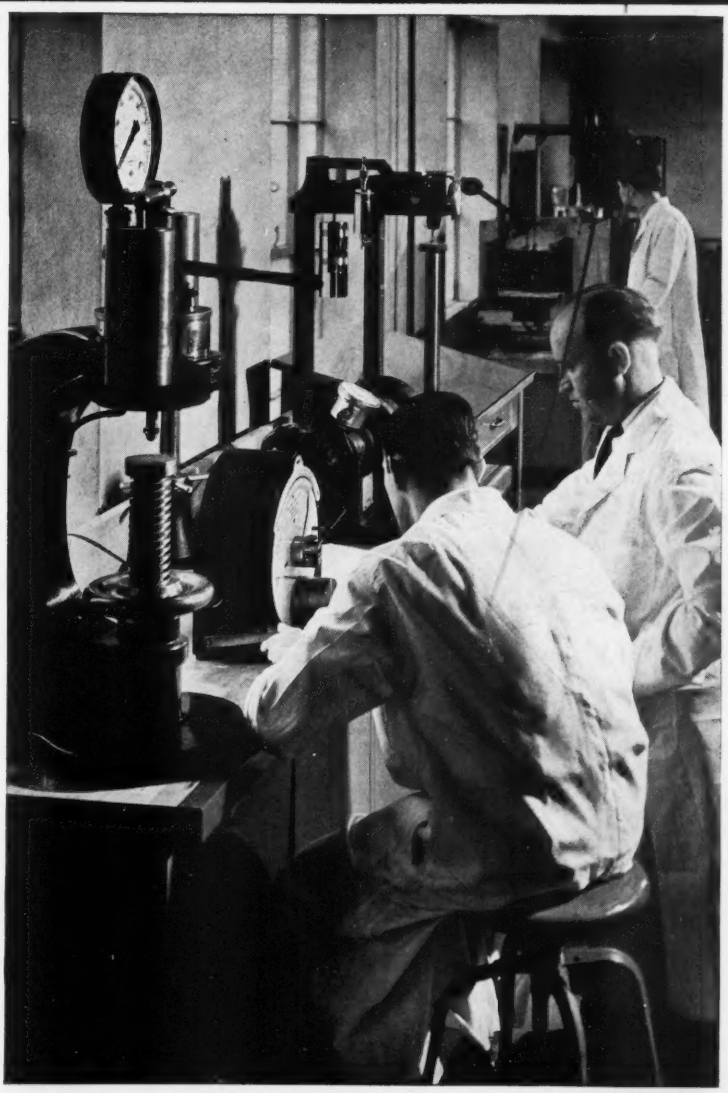
J&L WIRE SERVICE

CAN HELP YOU SAVE TIME, TROUBLE AND MONEY

When we know your manufacturing problems we can help you solve them right here in our laboratory.

That is why we have a special J & L wire service to work with your production people . . . to analyze your needs and create the best kind of wire for your particular product . . . to see that you are supplied with the right wire with the right finish for smooth, trouble-free production.

Ask for this J & L service. It can help you speed up production—and possibly institute new economies.



JONES & LAUGHLIN STEEL CORPORATION

AMERICAN IRON AND STEEL WORKS • PITTSBURGH, PENNSYLVANIA

J&L STEEL

J&L — PARTNER IN PROGRESS TO AMERICAN INDUSTRY

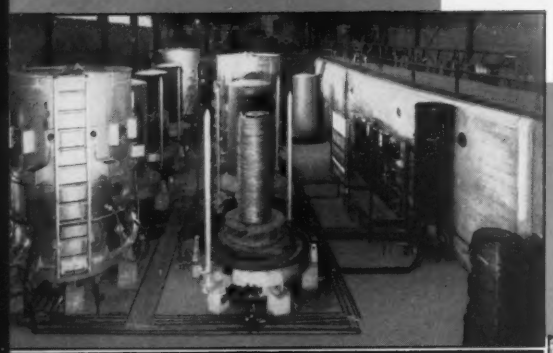
OFFICIAL PUBLICATION OF THE WIRE ASSOCIATION

WILSON

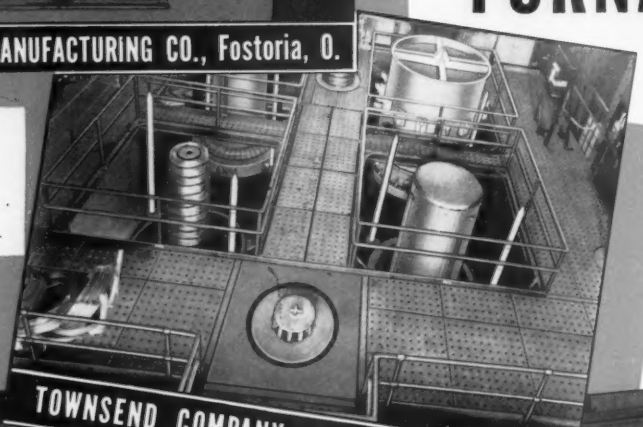
FURNACE INSTALLATION

for WIRE and ROD

Annealing



ENECA WIRE & MANUFACTURING CO., Fostoria, O.



TOWNSEND COMPANY, New Brighton, Pa.

The Wilson Annealing Unit is covered by Patents Nos. 1952402, 2068477, 2078356, 2081612, and other patents pending.

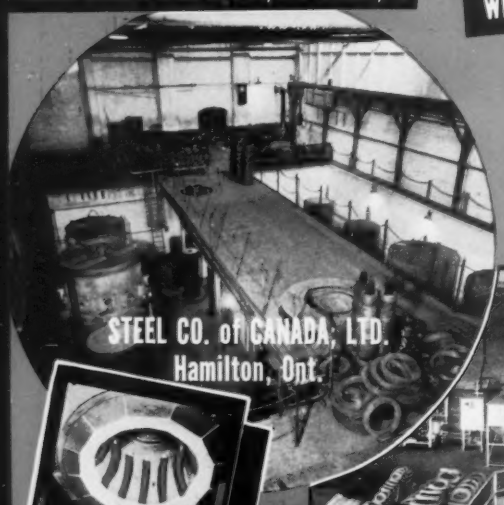
TIONAL SCREW & MFG. CO., Cleveland, O.

WICKWIRE-SPENCER STEEL CO., Buffalo, New York

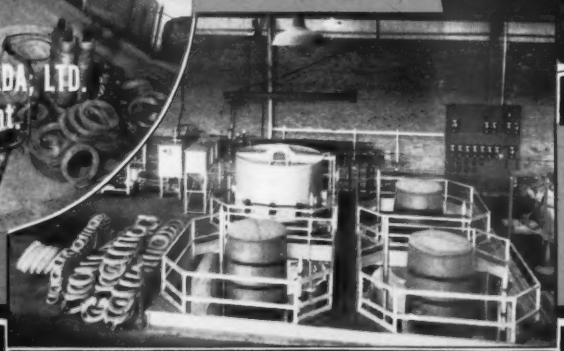
Wilson experience handling wire and r annealing problems available on call.

A NEW IDE Watch THE NEXT WILSON

WICKWIRE BROTHERS, Inc., Cortland, N. Y.



STEEL CO. of CANADA, LTD. Hamilton, Ont.



SHEFFIELD STEEL CORPORATION, Kansas City, Mo.

CONTINENTAL STEEL CORPORATION, Kokomo, I

end for the Anneal- ng Catalog showing ypical installations f Wilson Annealing urnaces.

An Exclusive Development of

LEE WILSON ENGINEERING CO.

1370 Blount Street • Cleveland, Ohio

SOLD BY THE WEAN ENGINERING CO., INC., WARREN, OHIO

Facts About the
CARBOLOY DIE PRICE REDUCTIONS
and revised specifications, effective Sept. 3, 1940

ON SEPTEMBER 3, 1940, Carboloy Company, Inc. announced the fifth in a series of price reductions affecting Carboloy dies, together with certain changes in quantity pricing schedule and revisions in standard die specifications.

The important features of these are as follows:

In addition to substantial reductions in prices affecting all users, further economies have been provided by a lowering of the quantities at which minimum prices prevail. On dies R-1 through R-6 minimum prices are reached on orders for 200 dies instead of a quantity of 1,000 previously required. On dies R-11 through R-18, minimum price quantities have been dropped from 50 to 5 dies.

Further benefits have been provided by increasing the nib sizes of dies R-10 through R-16. In this series, nib heights have been increased within a range of 1/16" to 3/8" to provide nibs more adaptable for push start bar drawing and tube sinking.

Due to the increased demand for Carboloy dies to draw tube and bar in sizes ranging from 2¾" to 3½", a new die—R-18—size 5.500 x 2.125, in a casing 9" x 3¾" has been added to the series of standard round hole dies, with resultant economies to the user.

The range of standard cored dies—introduced in 1937 for sizes R-1 through R-6 at specified hole sizes has been increased to include sizes R-7 through R-10 in hole sizes applicable to drawing fractional sizes of bar or tube from 3/16" to ¾" inclusive. Opportunities to obtain the benefits of simplified customer stocks and substantial savings are thus considerably extended.

Folder D-106, listing standard die prices and specifications sent upon request.

CARBOLOY COMPANY, INC.
DETROIT, MICHIGAN

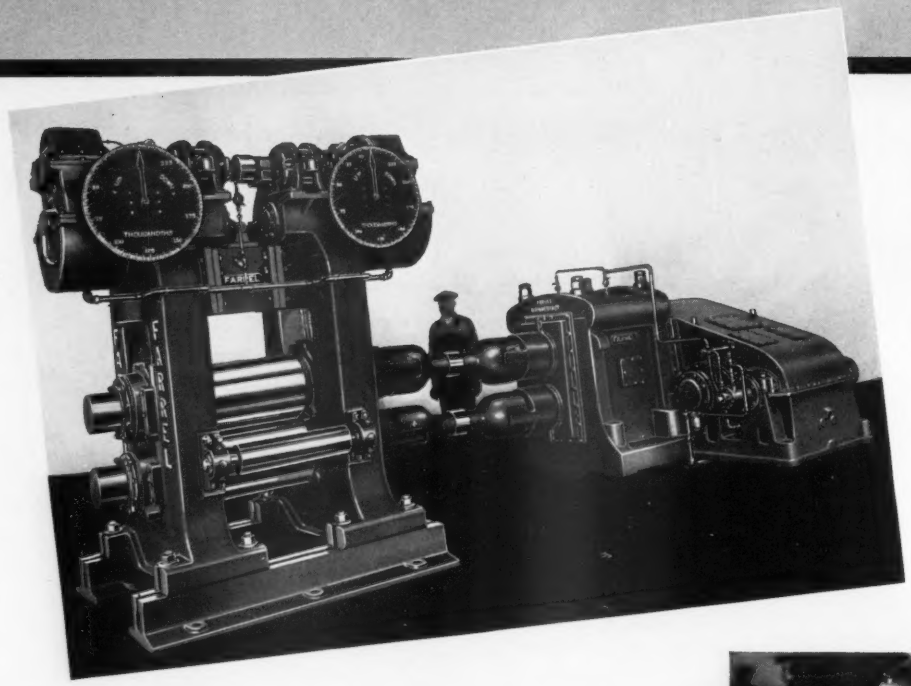
The Mark of CARBOLOY
REG. U.S. PAT. OFF.

CHICAGO • CLEVELAND • PITTSBURGH • NEWARK • PHILADELPHIA • WORCESTER, MASS.

Authorized Distributors: Hartley Wire Die Co., Thomaston, Conn. • Canadian General Electric Co., Ltd., Toronto, Canada

CARBOLOY REG. U.S. PAT. OFF. DRAWING AND SIZING DIES

NEW FARREL ROLLING MILL
for HEAVY DUTY *and* HIGH PRECISION



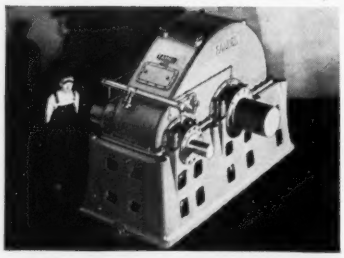
The 20" x 32" Two-High Cold Strip Mill illustrated above was designed for high precision rolling of aluminum, aluminum alloys, duralumin and other non-ferrous metals. Its heavy design and construction of high-strength materials permit the running of heavy passes and high speed operation for maximum output.

The rolls of this mill are forged tool steel, heat treated and hardened. They are carried in precision type, flood-lubricated sleeve bearings and connected to the pinion stand by universal spindles. The mill housings are of heavy section, made of cast steel.

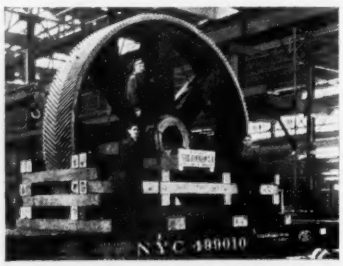
The double motor screwdown, built into the housings, provides ease of manipulation and facilitates setting the rolls with extreme accuracy. Adjustment can be made against the metal while the mill is in operation. A magnetic clutch permits the separate operation of each screw or the synchronization of both when both ends of the roll are to be adjusted together. The screwdown gearing is fully enclosed and is lubricated by a continuous circulating system.

The mill is driven by a combined double reduction gear unit and pinion stand which has Farrel-Sykes continuous tooth herringbone gears and pinions mounted in anti-friction roller bearings. A built-in oil pump provides spray lubrication of the gear teeth and flood lubrication of the bearings.

This mill is typical of the modern design features built into Farrel rolling mills which permit high speed operation, increase output, improve quality and reduce production costs. Our engineers will be glad to explain the various features available and their applicability to specific conditions.



Standard, Heavy Duty Single Reduction Rolling Mill Drive.



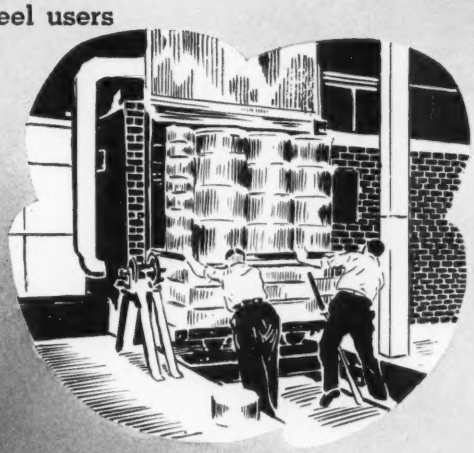
Farrel-Sykes Continuous Tooth Herringbone Gear for Rolling Mill Drive, 184.78" outside diameter.

FARREL

FARREL-BIRMINGHAM COMPANY, Inc.
ANSONIA, CONN.
New York • Buffalo • Pittsburgh • Akron • Chicago • Los Angeles

Better Grinding Wheel Production Facilities—Better NORTON SERVICE

The extensive Norton plant modernization program in the interest of Norton Service to grinding wheel users is now nearing completion.



New plant buildings permit greatly improved facilities:

— new tunnel kilns for increased burning capacity

— more and better equipment for such operations as truing, bushing, balancing, testing and grading

— an extensive conveyor system for easy handling without loss of time

A new department for organic process wheels (resinoid, rubber and shellac bonded) is equipped with the most modern press and oven equipment.

Alundum and Crystolon abrasives are being produced at the Norton electric furnace plant in both variety and quantity greater than ever before.

NORTON COMPANY, WORCESTER, MASS.

NORTON ABRASIVES

THE WIRE ASSOCIATION

WHAT IT GIVES YOU FOR $10.00 ANNUAL DUES

I. WIRE & WIRE PRODUCTS — For One Year.

The official publication of The Wire Association, covering the Wire Industry; its Metallurgy, Technology, Research, Processes, Machinery and Personnel.

Regular Subscription — $5.00 in U. S.
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II. THE ANNUAL BUYERS GUIDE AND YEAR BOOK OF THE WIRE ASSOCIATION.

A complete Directory of the Wire Industry, with alphabetical listings of its Products, Machinery and Raw Materials. Gives the source of all Supplies and Equipment used in both the Manufacture of Wire and Rod, and Wire Products produced therefrom.

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Regular Sales Price — $5.00.

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(In Association with American Society for Metals and The National Metal Congress.) Technical Sections, Plant Inspections.

V. REGIONAL MEETINGS.

Attendance at the Pittsburgh, Pa., and Worcester, Mass. meetings which include Local Plant Inspections, Technical Sessions and Discussions.

VI. PERSONAL CONTACTS.

Both at Annual and Regional Meetings, and throughout the year, for interchange of helpful information.

VII. INFORMATION SERVICE ON MACHINERY, EQUIPMENT AND SUPPLIES.

The Technical, Catalogue and Correspondence Files of the Wire Association hold the answer to practically every "Where can I buy" problem. This service is available to members without charge.

For Detailed Information Address

RICHARD E. BROWN,
EXECUTIVE SECRETARY

STAMFORD TRUST CO. BUILDING — STAMFORD, CONN.

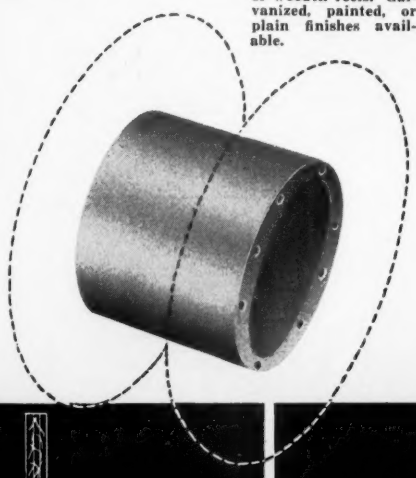
Stevens

LOW TARE STEEL REELS

Manufactured under license arrangements with Western Electric Company

Four Operations To Assemble Stevens Flanged Steel Drums

Can be used with plain or recessed heads, for all sizes of wooden reels. Galvanized, painted, or plain finishes available.

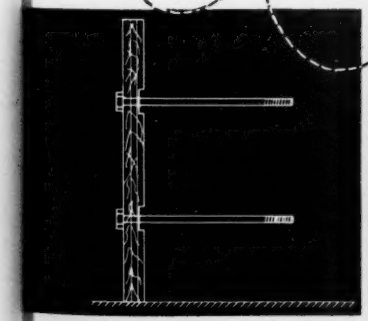


For Reel Economy

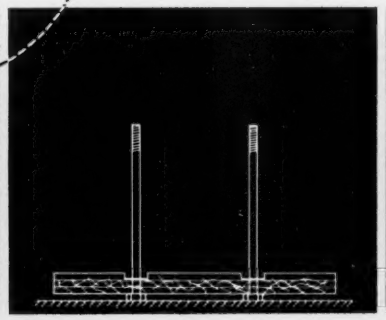
STEVENS Low Tare Shipping Reels are made in IPCA and special size from 36" to 84" diameter. They carry cable of all sizes. Efficiently designe plus careful workmanship, Stevens reels have low weight, long life and lo maintenance cost. They are sturdy at the hub and engineered with shoc absorbing characteristics to resist side stress.

Write today for further interesting data and prices.

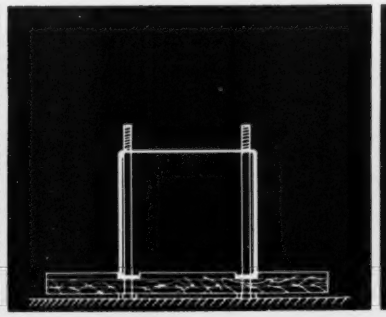
THE STEVENS METAL PRODUCTS CO., NILES, OHI



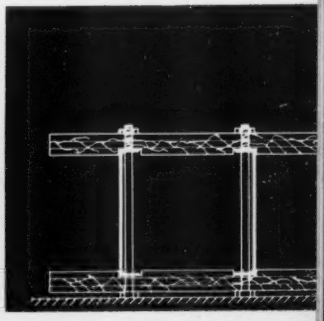
To assemble reels — FIRST OPERATION. Set first wooden head on edge and insert through bolts.



SECOND OPERATION. Then lay wooden head flat on floor.

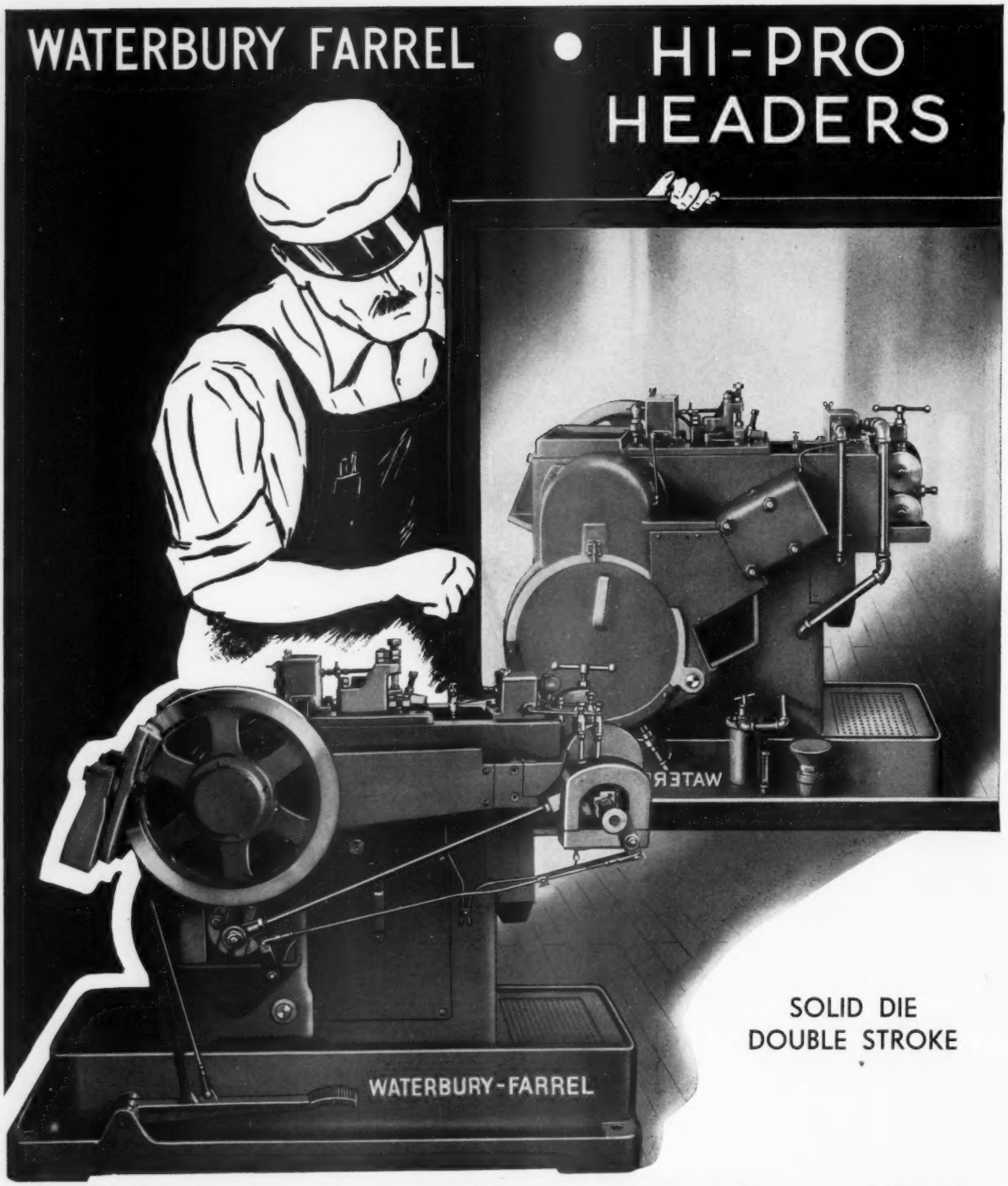


THIRD OPERATION. Put bolts through flanges of drum.



FOURTH OPERATION. Set seco wooden head on drum and screw n on bolts. This completes assembly.

WATERBURY FARREL • HI-PRO HEADERS



SOLID DIE
DOUBLE STROKE

For cold-heading rivet and screw blanks—These modern machines are designed to meet the present day demands for high speed, large quantity production, and economical operation — Two standard sizes: 3/16" by 1" at 225 per minute; 5/16" x 1½" at 175 per minute.

WATERBURY FARREL FOUNDRY AND MACHINE COMPANY

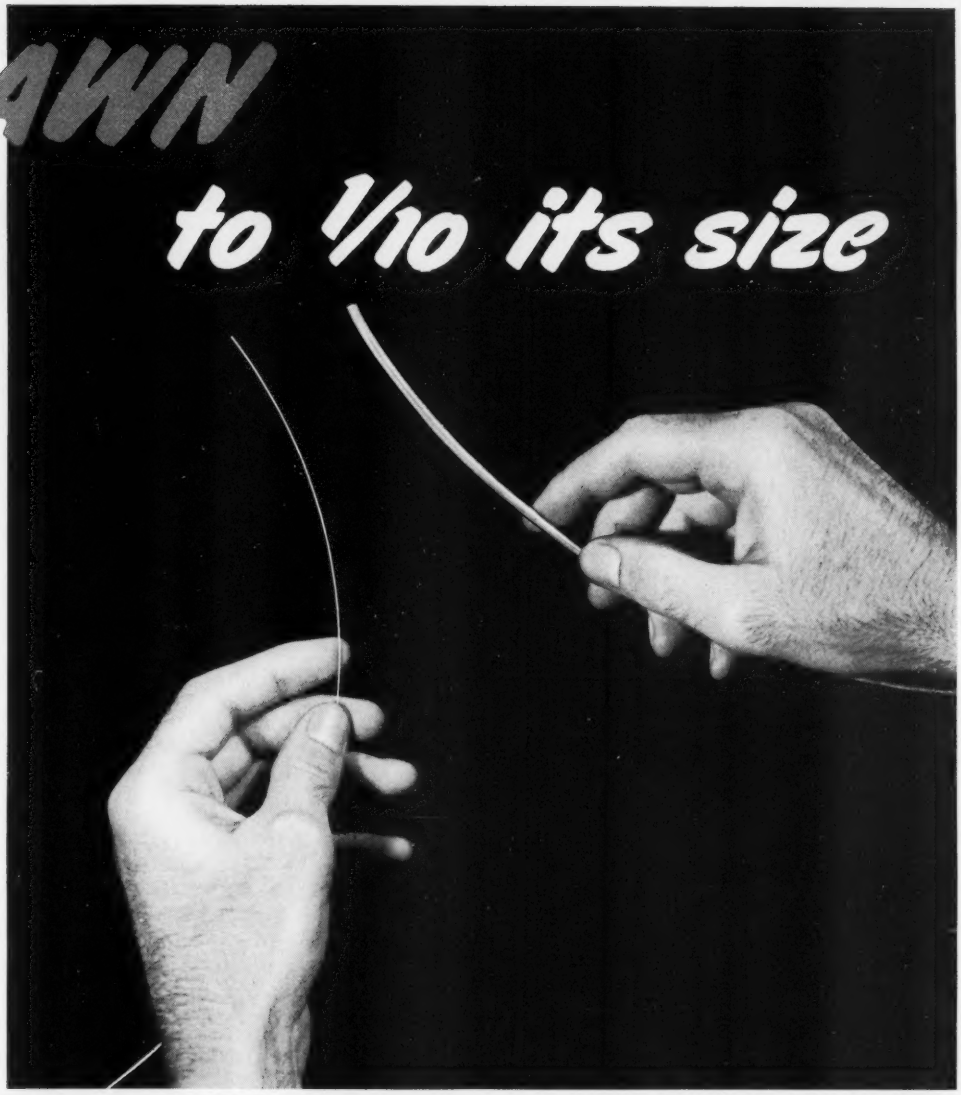
WATERBURY, CONNECTICUT

CLEVELAND CHICAGO NEWARK, N. J.

and insert through bolts.

on bolts. This completes assembly.

DRAWN to 1/10 its size



COATING UNHARMED

Here's dramatic proof of the vise-tightness of the electrolytic bethanized zinc coating. A manufacturer drew bethanized "A" coated wire down to 1/10 of its original size, without reducing the percentage of zinc to steel or damaging the tight, flawless coating in any way.

Here are the reasons why a bethanized coating can withstand such drastic treatment:

First of all, a bethanized coating is applied by electrolysis. The coating is 99.9+ per cent pure zinc. There is no intermediate layer of brittle zinc-iron alloy to reduce ductility. The unusually pure bethanized coating approaches a virgin metal in physical properties. It is virtually as ductile as gold leaf, passes through the dies smoothly without flaking or cracking. Furthermore, due to the nature of the electrolytic process, a bethanized coating is automatically uniform and can be applied in any practical predetermined thickness. There are no thin spots to lay bare in the drawing operation.

If you now make a wire product that requires galvanizing after deformation and fabrication to avoid cracking the zinc—consider the substitution of bethanized wire for the wire you are now using. Bethanized wire is ideal for chains, automotive accessories, pail handles and a host of other products. It reduces production costs, makes a better product, yet costs no more than ordinary wire for a given weight of zinc coating.

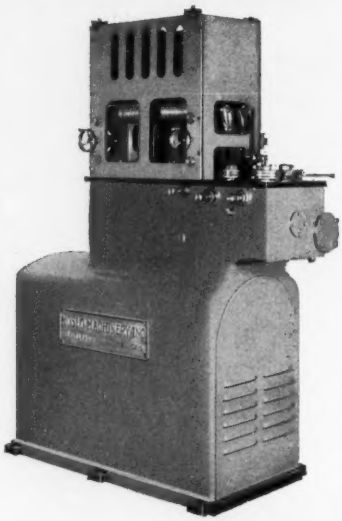
BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY

So you want

REAL PRODUCTION?

If feeding welding rod wire to your extrusion presses is a problem - -



THE MOSLO AUTOMATIC WELDING ROD HOPPER FEEDER IS YOUR ANSWER!

★ STURDY — "Hopper" All steel plate construction.
★ POSITIVE — Feed pressure maintained under spring tension.
★ FLEXIBLE — Single hand screw adjusts to wire sizes.
★ CAPACITY — Ample; requires infrequent loading.
★ ADJUSTABLE — Built for years of dependable service.
★ SERVICEABLE — Speed readily matched to extrusion press.

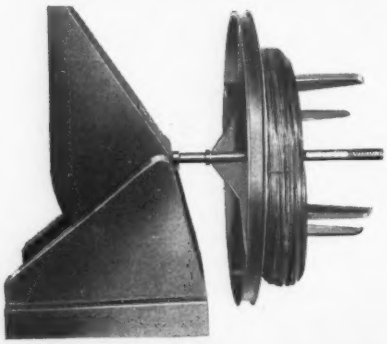
★ Driving mechanism totally enclosed, running in oil. ★ TIMKEN Bearings throughout. ★ Heat treated alloy steel gears. ★ Supplied for right or left hand operation. ★ Hopper is built to take care of customer's length and diameter requirements. ★

A CUSTOM BUILT FEEDER FOR A PRODUCTION JOB! WRITE TO-DAY FOR FULL INFORMATION!

"SHIFTWEIGHT WIRE REELS"

SAVE THE MAN! INSTALL SHIFTWEIGHT
COUNTER BALANCED TILTING WIRE REELS

One man loading.
300 pound capacity.
Adjustable arms.
Snarlproof.



Fluid principle counterweight.
All welded steel construction.
No bolting to floor.
Adjustable tension brake.

MOSLO MACHINERY, INCORPORATED

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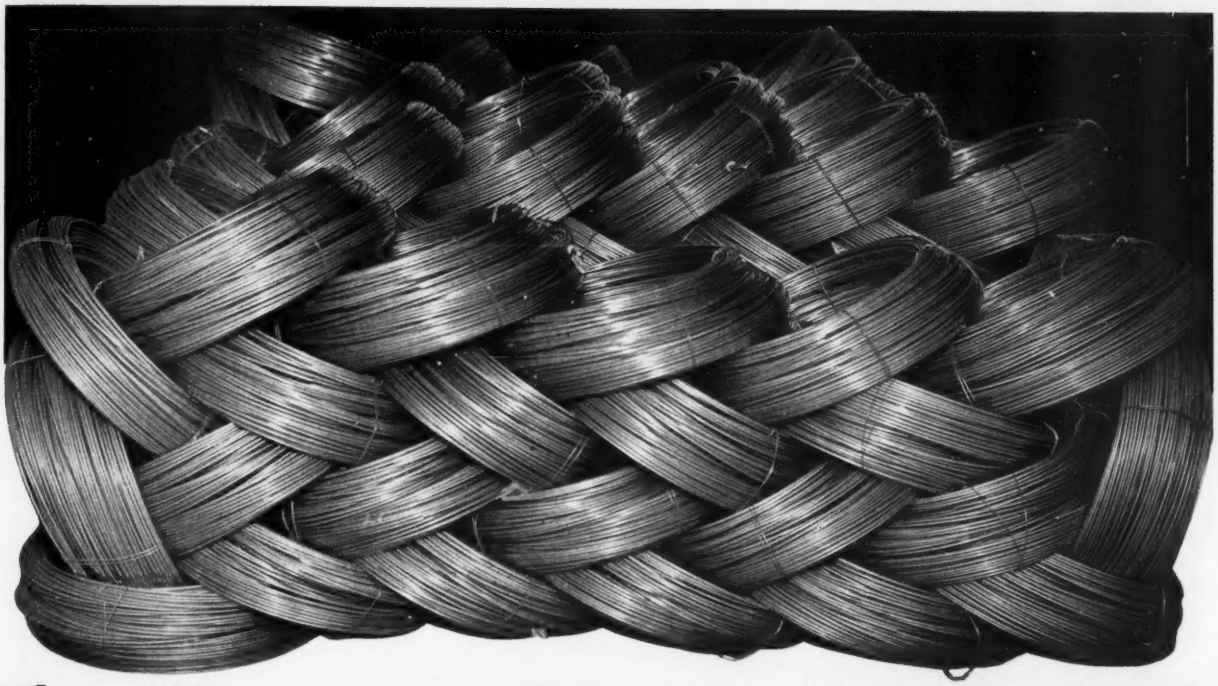
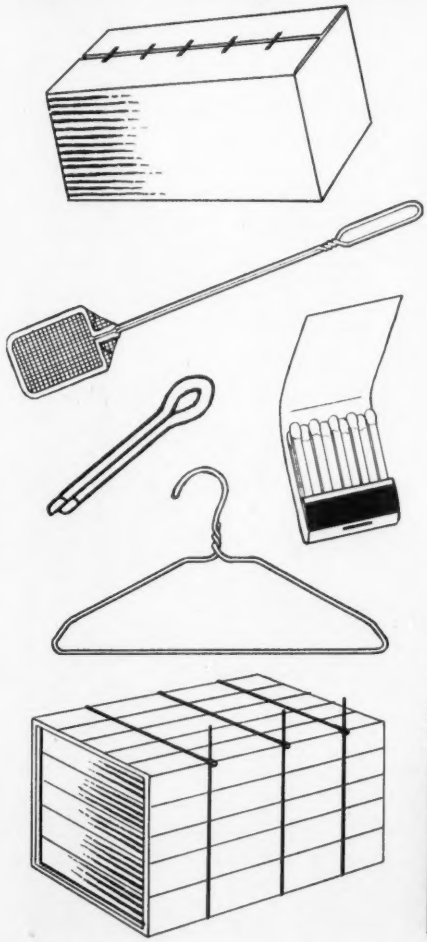


The Way to SMOOTHER PRODUCTION FEWER REJECTIONS . . . LOWER COSTS



Continental is prepared to meet the specifications of manufacturers for many special kinds of low carbon wire shapes and analyses. Continental metallurgists are always glad to work with manufacturers on their problems. As specialists in low-carbon wire, we often can furnish a combination of analysis, temper and finish that simplifies fabrication and improves the final product. Besides special-analysis and copper-bearing steel wire, Continental offers wire of Konik, the patented new steel containing copper, nickel and chromium.

Among the finishes offered by Continental are bright, bright and black annealed; sull-coated; processed; galvanized, including Flame - Sealed; liquored, coppered and tinned in many modifications. Eight shapes are standard, and many specials available. Regular gauges run from No. 34 to ⅜ inch. Furnished in coils of suitable sizes, or straightened and cut to specification.

CONTINENTAL STEEL CORPORATION

General Offices: Kokomo, Indiana • Plants at Canton, Kokomo, Indianapolis

CONTINENTAL

STEEL SHEETS AND WIRE PRODUCTS

Wire: Bright Basic, Annealed, *Konik, Special Manufacturers, Galvanized, *Flame-Sealed

Wire Rods, Nails, Staples, Bale Ties, Barbed Wire, Fence Types; Gates and Fittings

Sheets: Black, Galvanized, Special Coated Roofing and Siding 14 Styles

*Trade Mark Registered, U. S. Patent Office

You can't afford to miss the biggest National Metal Exposition and Congress in History.

Be sure to attend the biggest National Metal Exposition and Metal Congress in history at Cleveland this year. More than 275 exhibits will be on display and in actual operation at the Exposition — an opportunity to see and examine every new development in the metal industry.

And at the daily technical meetings of the Metal Congress over 70 lectures on various phases of production, processing and fabrication of metals will be presented by leading authorities in your field.

You owe it to yourself and to the advancement of your company's welfare to attend this great annual event. Make your hotel reservations today to insure best accommodations.

A complete program of technical sessions and list of exhibits will be available for distribution about October 1st. Write for your copy to the American Society for Metals, 7301 Euclid Avenue, Cleveland, Ohio.

The WORLD'S GREATEST EVENT IN THE METAL INDUSTRY
70% NEW ATTENDANCE EACH YEAR

COOPERATING SOCIETIES

American Society for Metals; American Welding Society; The Wire Association; Iron and Steel Division and Institute of Metals Division, American Institute of Mining & Metallurgical Engineers.

NATIONAL METAL EXPOSITION
AND METAL CONGRESS

Cleveland, Ohio

OCTOBER 21-25, 1940

Managed by American Society for Metals

"STANDARD" TURKS HEADS

THE FASTEST AND MOST ECONOMICAL METHOD OF:—

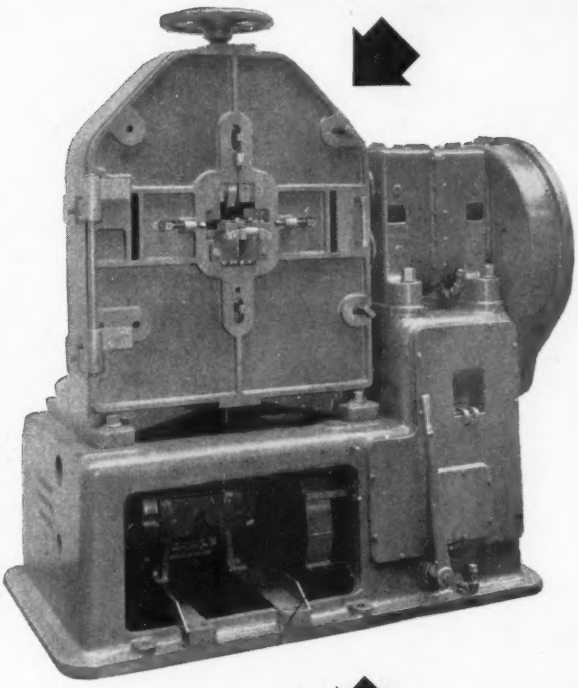
1 FORMING SPECIAL SHAPES FROM ROUND WIRE. . . . .

2 EMBOSSING DESIGNS AND TRADEMARKING. . . . . .

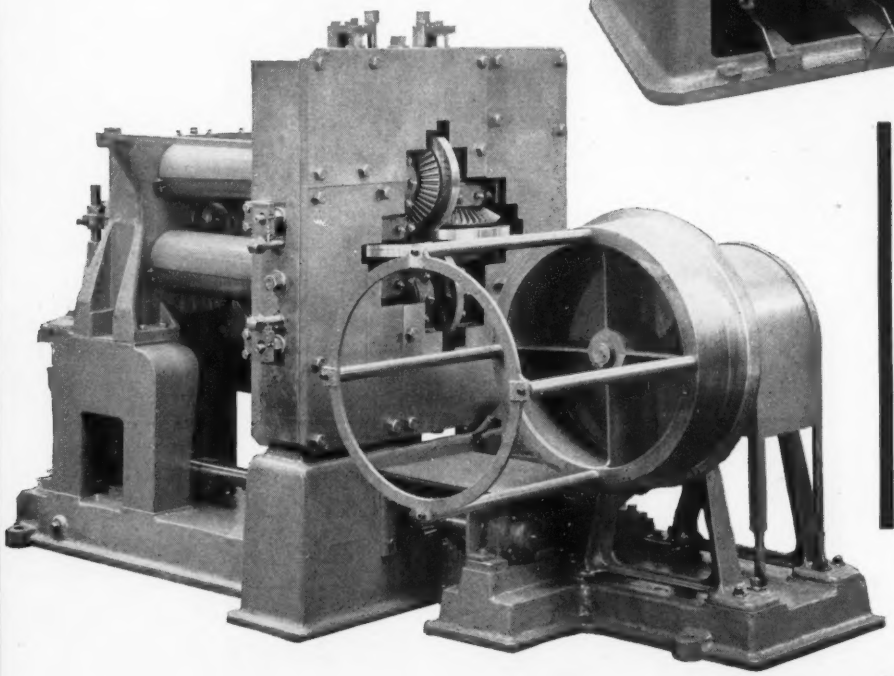
"Standard" Turks Heads, or adjustable draw plates, efficiently replace solid dies in reducing and forming wire from the round to rectangular and special shapes.

Available **with friction rolls** for light stock and short runs; **with power driven rolls** for higher rate of production, eliminating the need for a bull block or draw bench for moving the wire through the draw plates.

Rolled finished surfaces, characteristic of Turks Heads, are superior to solid die formed surfaces. Adjustment includes the forming of corners — sharp to well rounded.



The Power Driven Plain Type Turks Head used for forming special shapes — with formed rolls — and for embossing designs on special shapes.



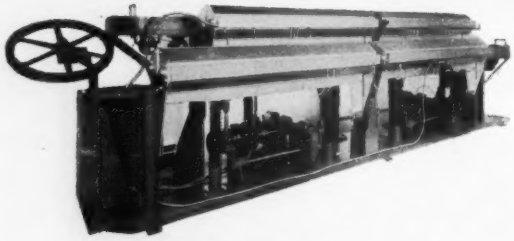
The Power Driven Universal Type — with flat rolls only — is used for converting round wire into rectangular shapes, allowing for a wide variation in section size.

Write, stating your requirements (shape, stock, production, etc.) and we shall be glad to send specific recommendations, including price and delivery.

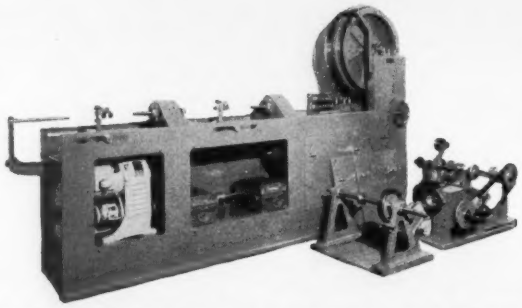
IT'S **STANDARD** PRACTICE

MACHINERY COMPANY

PROVIDENCE, RHODE ISLAND



ELECTRIC BAKING OVEN
for Varnished Glass
Insulated Wire, with Varnish Applicators and
Thermostatic Control.



WIRE INSULATION COVERING MACHINE
Ball Bearing Mounted
with Variable Speed Motor Drives.
For All Types of Insulations

▼▼▼

EST. 1855 AIMCO INC. 1915
"American"
AIM INSULATING MACHINERY COMPANY
517 West Huntingdon St.
PHILADELPHIA PENNSYLVANIA U.S.A.

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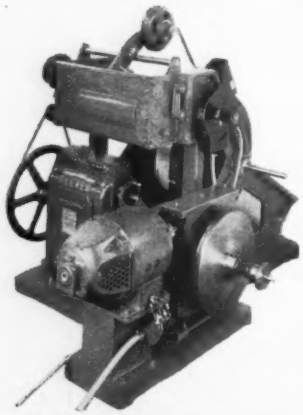
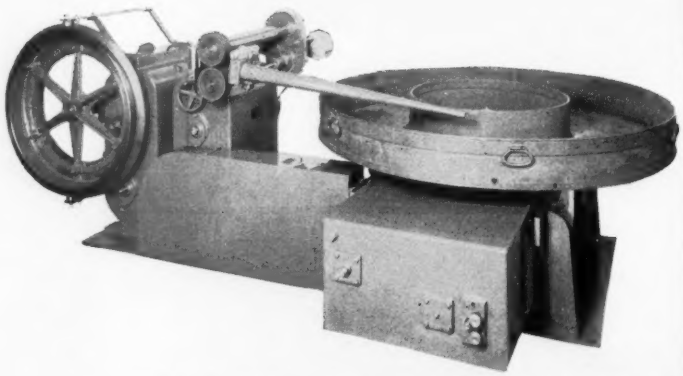


TAKE-UP REEL-STAND
Ball Bearing Mounted
Motor Driven, Adjustable Traverse. Built also in both Multiple Horizontal and Vertical Units.



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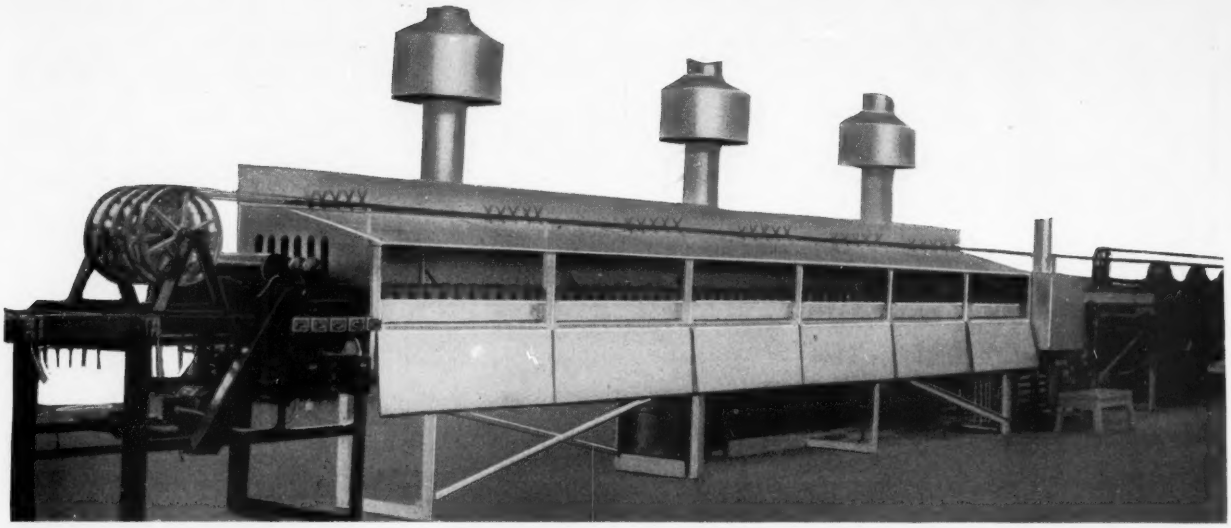

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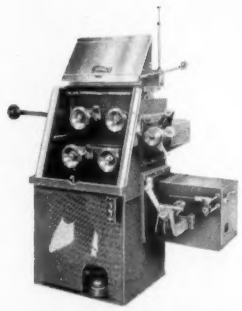

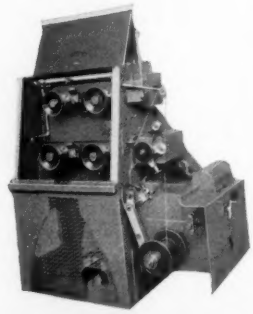

The production line system employed by the Syncro Continuous Annealing and Tinning Machine, assures high speed, quality production at low cost. Soft wire entering this machine is annealed by the economical open flame method, or it is annealed and tinned as it passes through the machine and it is finally reeled ready for shipment.

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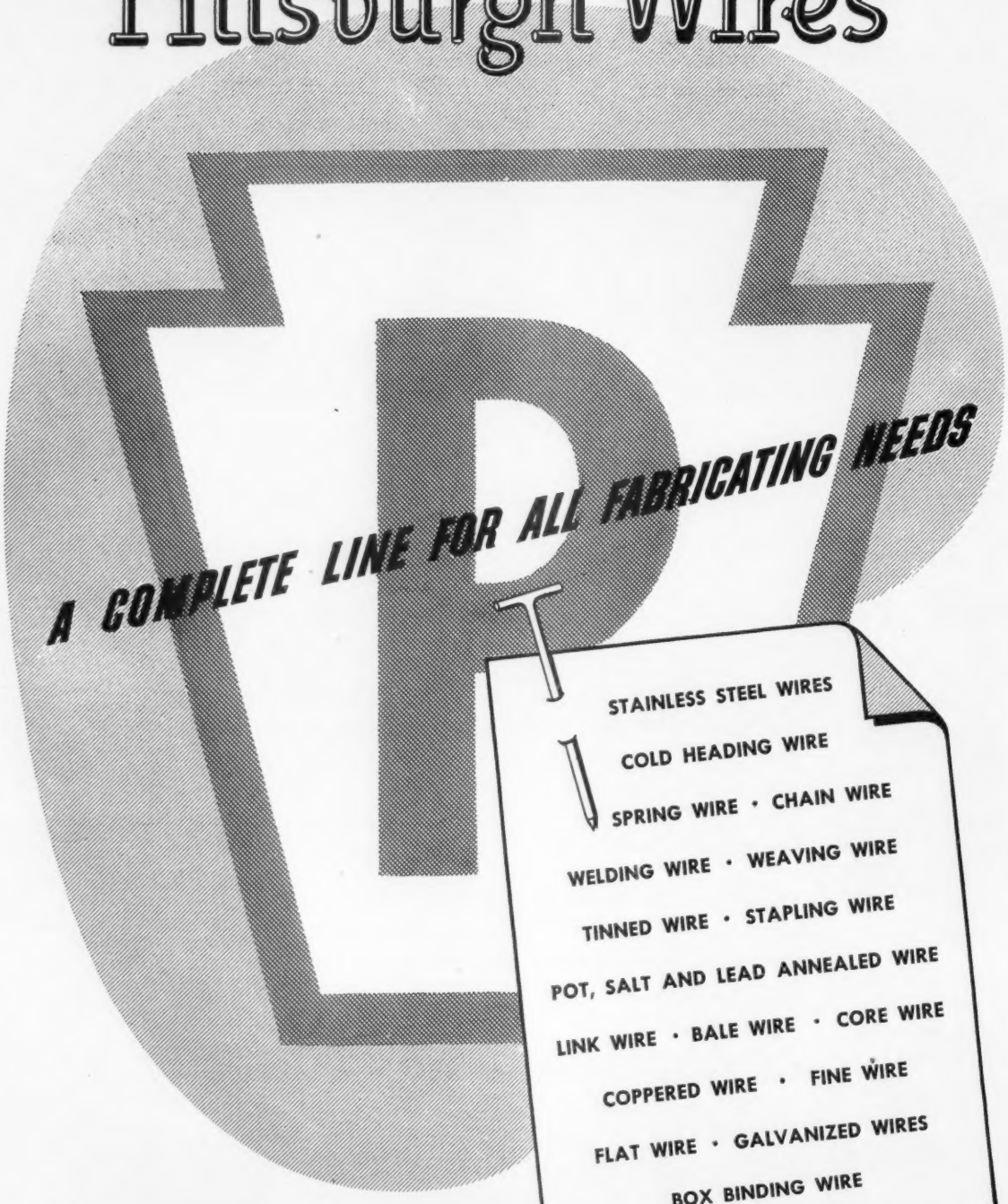
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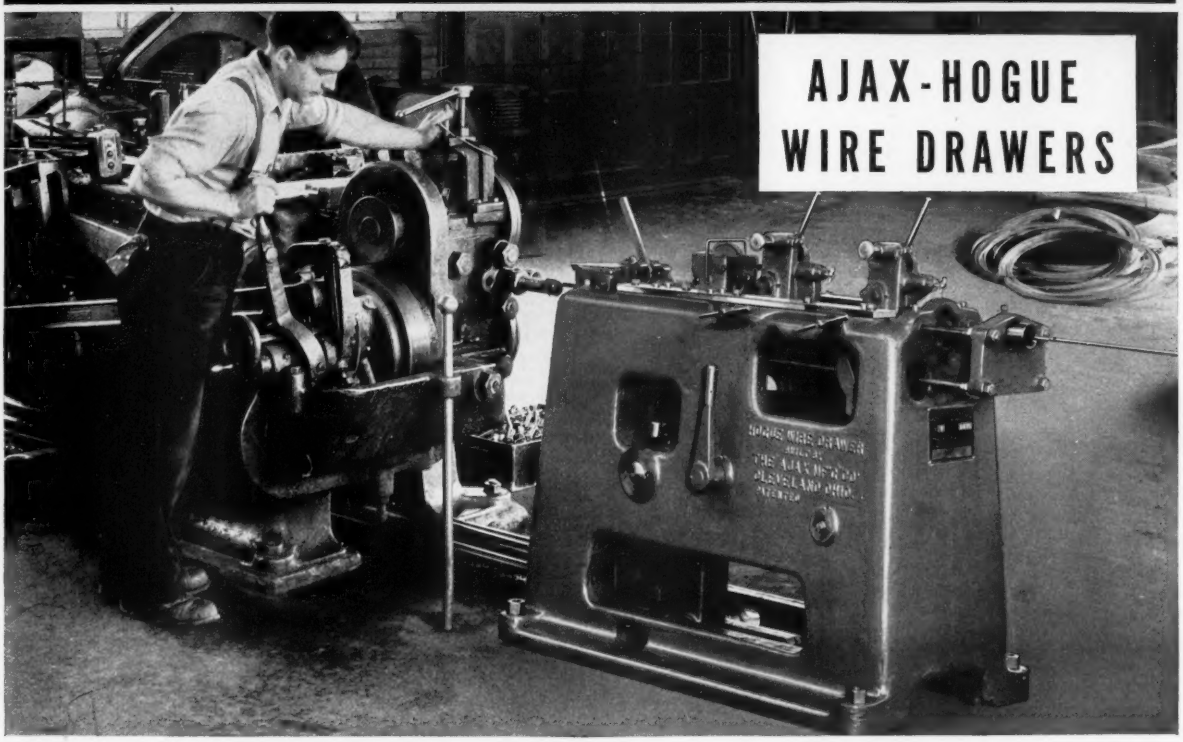

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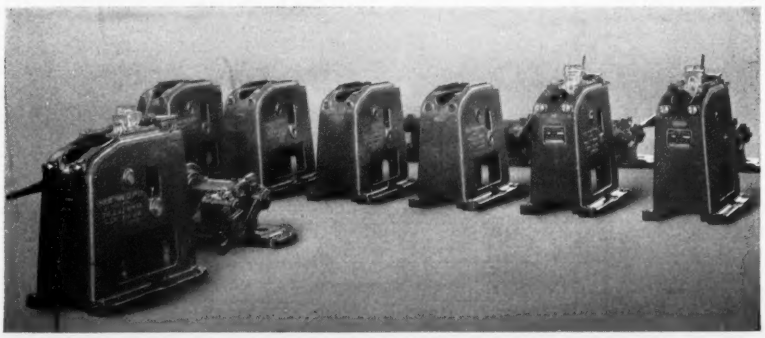

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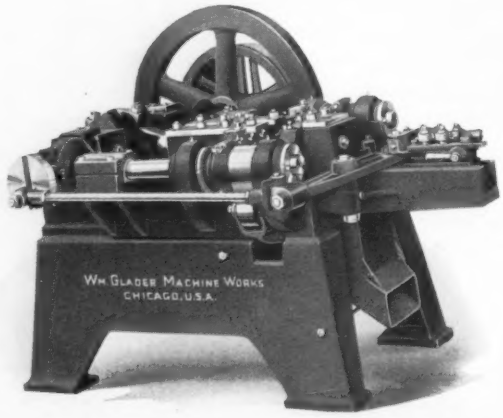

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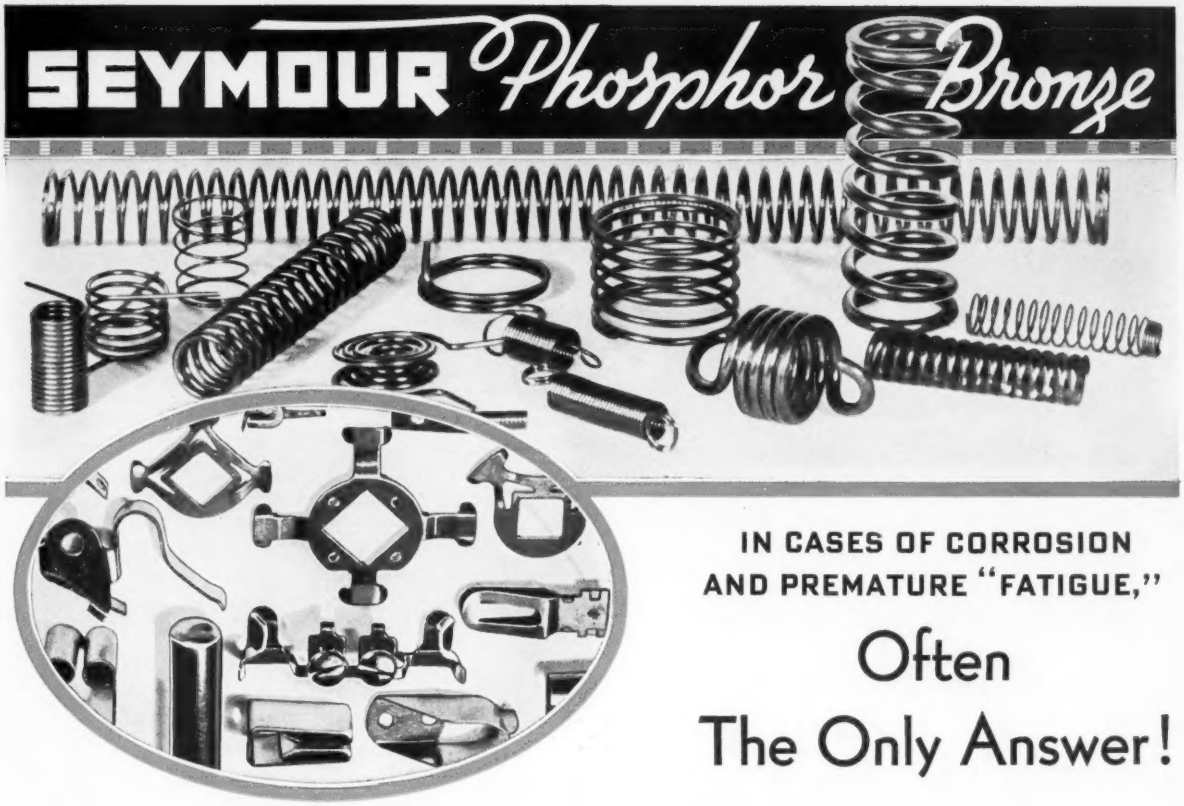
#00A	#16	1⅛"	700	37.2
#00	#14	1¼"	550	55
#0	#12	1¾"	450	89
#1	#10	2½"	400	192
#2	#8	3½"	325	310
#3	#4	5"	225	523
#4	#1	7"	190	622
#4s	5/16"	9"	175	1155
#5	⅜"	12"	160	2400

This high output and economical operation account for the GLADER machine being accepted as standard equipment in all recent installations.

SEYMOUR *Phosphor Bronze*



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Unless firmly resisted he will sabotage every vulnerable part of your product. Knowing this, far-sighted designers and production engineers thwart the ravages of corrosion by making such items as springs, slides, nuts, cams, trimmings, etc., of Seymour Phosphor Bronze.

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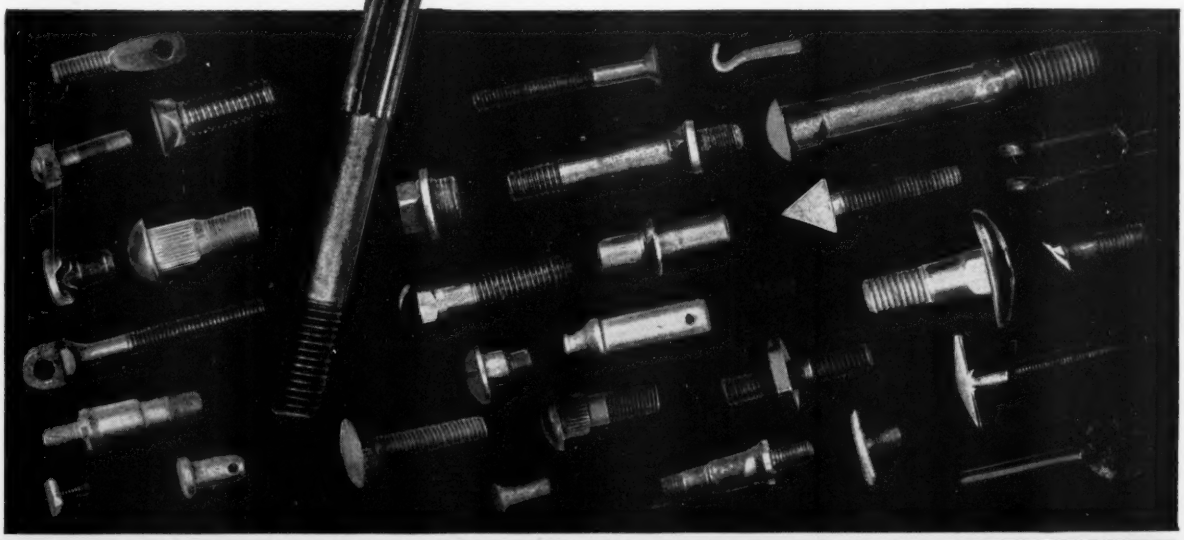

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To Attend
The Tenth Annual Convention
of the
Wire Association

CONVENTION HEADQUARTERS WILL BE AT THE HOTEL CARTER

✦ ✦ ✦

IN addition to the program shown on pages 607-610, a splendid opportunity is offered to discuss informally, routine production problems and to exchange opinions and ideas regarding equipment and processes used in the industry.

✦ ✦ ✦

FOR this purpose informal gatherings are held at the Wire Association headquarters in the Hotel Carter, which are open from 9 A. M. to 11 P. M. during the convention.

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EVERY wire production executive engaged in the manufacture or fabrication of wire and wire products of any kind is invited to join The Wire Association and attend these meetings.

✦ ✦ ✦

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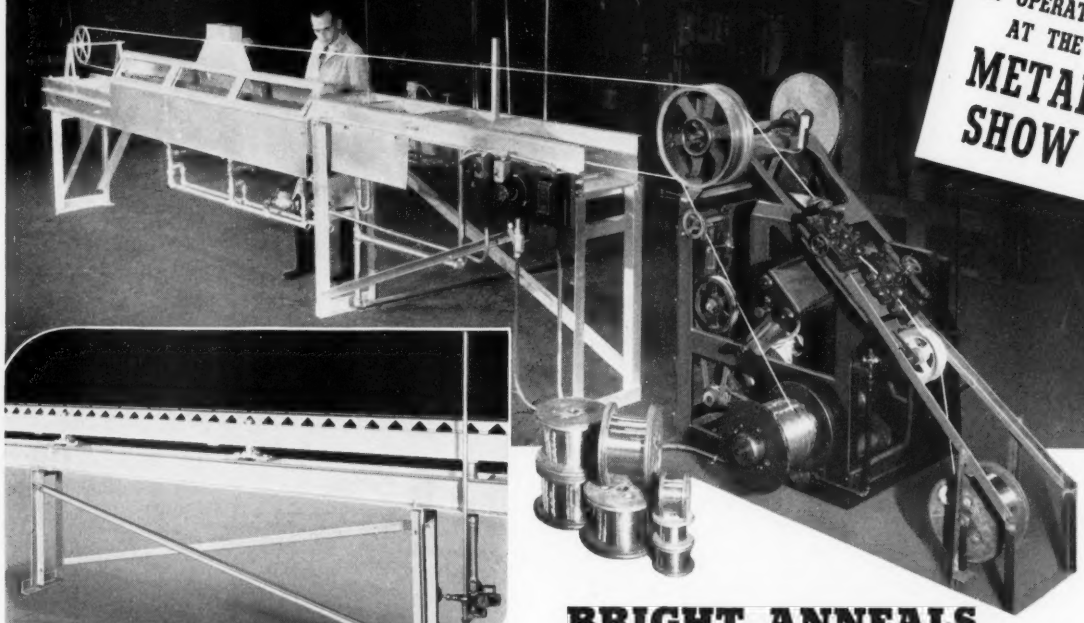
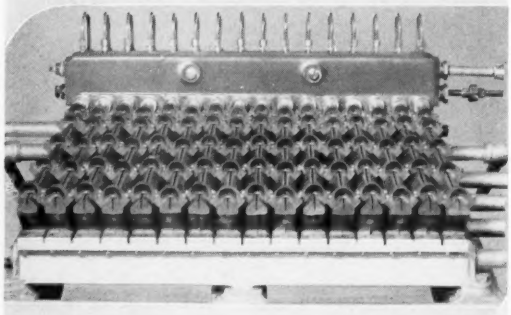
IN OPERATION AT THE METAL SHOW



● Wire can be treated in single or multiple strands. Illustration above shows a portion of a single 27-foot burner.



● Burners for a 16-line unit. Each line has an individual anneal indicator. Note wire guides centered above burners.

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● Here is your chance to see in operation the new open-flame unit for continuously bright annealing non-ferrous wire in strands. This new principle of bright annealing non-ferrous wire completely dispenses with the conventional furnace. In place of a furnace, the wire in strands, is guided through a predetermined position in the flame of a specially designed burner — every portion of the wire receiving the identical same treatment. Depending on the gauge, speeds up to 1500 feet per minute are used. At all speeds the degree of anneal is shown constantly by a visual indicator. For tinning and enameling, specially developed units are incorporated directly into the line.

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WIRE AND WIRE PRODUCTS

A monthly publication devoted to the production of Wire, Rod and Strip, Wire and Rod Products and Insulated Wire and Cable

DRAWING—ROLLING—EXTRUDING—FORMING—FABRICATING

Vol. 15 OCTOBER, 1940 No. 10

Designated as

Official Publication By The Wire Association

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A monthly publication devoted to the production of Wire, Rod and Strip.
Wire Products and Insulated Wire and Cable.
DRAWING --- ROLLING --- EXTRUDING --- FORMING --- FABRICATING

Vol. 15 OCTOBER, 1940 No. 10

Reactive Wire Drawing

(A Monograph)

By H. A. Stringfellow

Worcester, Mass.

Four years ago, when I was attempting to rationalize a number of experimental determinations on back tension drawing in the light of orthodox metallurgical concepts, I found myself at a stalemate. Either my observations were incorrect, or the accepted concepts of metallurgy were at fault. ✦ ✦ ✦ ✦ ✦ ✦

At that time I made the following note: The amount of work required to reduce any particular piece of steel a given amount is a function of the character of the forces acting upon the steel and the manner in which those forces are applied. This was only my private notation to which, at that time, I could not furnish any convincing quantitative proof. Since that time I have been able to make fifty determinations on the work of reduction on an experimental Reactive Wire Drawing Machine and the accompanying tables give the details of the observations and calculations involved in seven typical determinations. ✦ ✦ ✦ ✦

THE AUTHOR.

H. A. STRINGFELLOW

Graduated as Civil Engineer, 1910 from Rensselaer Polytechnic Institute. Head Instructor, Civil Engineering, Mechanics Institute, Rochester, New York, 1913-15. Civil Engineering work in United States, Japan, China, the Philippine Islands and South America, 1917 to 1926. From then until 1930 engaged in developing the compacting process for rounding and compacting the cables of the George Washington Bridge for the Southwark Foundry and Machine Company. Following this until 1934, in charge of Special Machinery Division, Elevator Supplies Company. In 1935 started investigation and research work on back pull drawing from which the present Reactive Wire Drawing method has developed.

THE conventional conception of the work of reduction is that the amount of work required to reduce any particular piece of steel a given amount is a fixed quantity. It can be readily understood how this error developed, as far as wire drawing is concerned. Before the advent of Reactive Drawing there was only one way in which wire could be reduced.

✦ ✦ ✦

IT is well known that in order to reduce a wire the stress in the wire, in the die, must be raised to the mean yield point. By conventional methods of drawing there is only one way in which this can be accomplished; by applying a pull on the wire which will produce the mean yield point stress in the die. As this stress is a fixed quantity for any particular wire and the measure of work is the die pull multiplied by the distance moved through the die, the amount of work done was consequently a fixed quantity in all cases (with the same wire). The fact was never considered that the same result could be attained if the mean yield point could be arrived at with

FIG. 1

Determination No.	Draft and % Reduction	Type of Drawing	(A-a)	Mean Area	Friction Factor	Die Pressure in lbs.	Reactive Load in lbs.	Effective Plastic Stress, lbs. sq. in.	Effective Elastic Stress, lbs. sq. in.	Mean Yield Point lbs. sq. in.	Elastic Resilience, ft. lbs. per 100′ of Wire	Work of Die Pressure, ft. lbs. per 100′ of Wire	Total Work of Reduction, ft. lbs. per 100′ of Wire	Total Heat B. T. U. per 100′ of Wire	% Reduction in Heat
1	.042 to .036 27%	Conv. 50% R. 31% R.	.0004	.0012	2.1	120 70 90	 70 40	 83,000 107,000	 58,000 33,000	143,000 141,000 140,000	 7.0 3.0	12,000 7,007 9,000	12,000 7,007 9,003	16.0 9.0 12.0	 44% 25%
2	.036 to .030 31%	Conv. 50% R. 31% R.	.0003	.0009	2.0	98 60 80	 60 36	 100,000 133,000	 67,000 40,000	163,000 167,000 173,000	 7.0 3.0	9,800 6,000 8,000	9,800 6,007 8,003	13.0 8.0 10.0	 38% 23%
3	.080 to .072 19%	Conv. 50% R. 31% R.	.0010	.0046	2.3	194 128 160	 128 72	 56,000 70,000	 28,000 16,000	84,000 84,000 86,000	 6.0 2.0	19,400 12,800 16,000	19,400 12,806 16,002	25.0 17.0 21.0	 32% 16%
4	.054 to .046 27%	Conv. 50% R. 31% R.	.0006	.0020	2.1	128 92 ..	 92 ..	 72,000	 30,000	102,000 102,000	 3.0 ..	12,800 9,200	12,800 9,203	17.0 12.0 ..	 29% ...
5	.080 to .072 19%	Conv. 50% R. 31% R.	.0010	.0046	2.3	228 140 178	 140 80	 61,000 78,000	 34,000 17,000	99,000 95,000 95,000	 9.0 3.0	22,800 14,000 17,800	22,800 14,009 17,803	29.0 18.0 23.0	 38% 21%
6	.069 to .060 24%	Conv. 50% R. 31% R.	.0009	.0033	2.2	200 132 162	 132 73	 67,000 82,000	 40,000 22,000	101,000 107,000 104,000	 9.0 3.0	20,000 13,200 16,200	20,000 13,209 16,203	26.0 17.0 21.0	 35% 19%
7	.080 to .072 19%	Conv. 50% R. 31% R.	.0020	.0046	2.3	105 .. 90	 .. 40	 39,000	 8,000	46,000 47,000	 .. 1.0	10,500 9,000	10,500 9,001	14.0 .. 12.0	 ... 14%

Note: In the column headed "Type of Drawing", 50% R. and 31% R. stand for Reactive Drawing with 50% and 31% pull ratio, respectively.

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less work. In other words, the method of arriving at the mean yield point was the measure, rather than the mean yield point itself, which latter was the important thing.

✦ ✦ ✦

THE note which I made four years ago has been proven to be correct by using a different method of reduction, which method can be varied within extreme limits. The results reported in the accompanying table Fig. 1, cover extreme variations in both method and materials worked on and can therefore be accepted as representative of all conditions of reduction.

✦ ✦ ✦

Referring to the table Fig. 1:

Determinations Nos. 1 and 2 were made on a .60 C. wire which was patented and drawn from .080″ diameter.

Determinations Nos. 3 and 4 were made on a .60 C. wire which was annealed and drawn from .080″ diameter.

Determinations Nos. 5 and 6 were made on a .92 C. wire which was annealed and drawn from .080″ diameter.

Determination No. 7 was made on a .06 C. wire which was annealed and drawn from .080″ diameter.

✦ ✦ ✦

IT will be noted that in every determination made, regardless of the method of drawing used, the mean yield point for that particular wire is the same.

✦ ✦ ✦

IT will also be noted that the total work of reduction varies widely with the different methods of reduction used.

✦ ✦ ✦

THE explanation of this apparent anomaly is as follows: The total stress in the die cone, which is the reducing stress, is the normal pressure per square inch acting upon the die surface, multiplied by the area of the surface of the frustrum of a cone whose bases are the entering and drawn wire, respectively:

A = area of entering wire
a = area of drawn wire
α = ½ the die angle

By the simple formulas of mensuration:

(1) Effective area of die = (A—a) sin α

n = component of the die stress acting normal to the die wall area.

H = horizontal component of that stress, or the deforming portion of the die pull.

(2) $H = ((A-a)/\sin\alpha)n \times \sin\alpha$

Which reduces to:

(3) $H = (A-a)n$

IN order to reduce a wire n must equal the mean yield point of the wire. This formula, however, does not take into account the die friction; and this friction is a large percentage of the total die pull.

μ = coefficient of friction.

✦ ✦ ✦

THE total friction in the die is the total normal pressure multiplied by the coefficient of friction and as this friction acts parallel to the wall of the die, the resulting friction factor must be multiplied by the cosine of half the die angle in order to obtain the frictional component in the direction of drawing. Call this component F.

(4) $F = ((A-a)/\sin\alpha)n \times \mu \cos\alpha$

(5) $F = ((A-a)n(\mu \cos\alpha)$

✦ ✦ ✦

IN order to obtain the total die pull, the horizontal components of the deforming and frictional forces must be added. Therefore, adding equations (3) and (5):

(6) $H = (A-a)n + ((A-a)n)\mu \cot\alpha$

Which reduces to:

(7) $H = (A-a)n(1 + \mu \cot\alpha)$

✦ ✦ ✦

EQUATION (7) is the basic equation for die pull, including friction in the die. This equation was first developed by **Mr. Kenneth B. Lewis** in his article on die stresses published in WIRE AND WIRE PRODUCTS of Sept. 1938 and has been proven to be correct for conventional drawing by experimental determinations.

✦ ✦ ✦

THE friction factor, $(1 + \mu \cot \alpha)$, experimentally determined by **Mr. Lewis**, is obtained from the **Lewis** curve Fig. 2. This curve gives the friction factor as a function of the percent reduction.

✦ ✦ ✦

KNOWING the die pull and using equation (7) and the Lewis curve, the mean yield point can be computed for any die pull. The conventional yield points given in the table Fig. 1, were computed in this manner.

✦ ✦ ✦

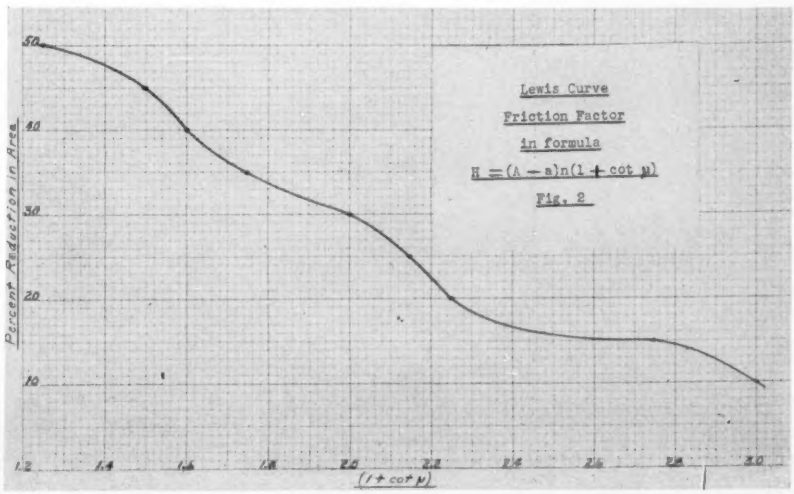
WHEN Reactive deformations are considered, an entirely new problem is presented. The effective plastic stress, as seen from the table Fig. 1, is obviously not sufficient to reduce the wire as this stress is considerably less than the mean yield point. An additional stress is required and this stress is furnished by the Reactive load, or back tension if you prefer to call it by that name, which really means prestressing the wire as it enters the die cone.

✦ ✦ ✦

THE total deforming stress, regardless of the manner in which the wire is drawn, is made up of two portions; an elastic stress and a plastic stress. The strain produced by the elastic stress is removed when this stress is removed. The strain produced by the plastic stress produces permanent deformation. When drawing Reactively, the elastic stress is produced by the Reactive load, or pre-stressing.

✦ ✦ ✦

IN discussing the action of the Reactive load in the reduction



of wire, it is necessary to go back to one of the first principles in Strength of Materials: **Hook's Law**, which states that, below the elastic limit, stress is proportional to strain. Also, working below the elastic limit, when the stress is removed, the strain is also removed and returns to zero. Repeated applications of stress below the elastic limit will raise the elastic limit, but in no case will a permanent set be produced in the material.

✦ ✦ ✦

THIS elastic work is termed resilience and is arrived at in the following manner:

S = unit stress
e = unit strain
E = modulus of elasticity of the material
D = S/e
P = total force applied
A = area of wire
l = length of wire
d = deformation of wire under the applied stress
P = SA
d = el
R = work in inch pounds (resilience)

✦ ✦ ✦

SINCE the strain, and also the deformation, varies directly as the stress applied, the total work done in straining a wire can be represented by a right triangle, the base of which is proportional to the strain and the vertical side proportional to the stress. The area of this triangle is proportional to the total work done in straining the wire. Therefore:

$R = \frac{1}{2}Pd$
$R = \frac{1}{2}SeAl$
$e = S/E$
$R = \frac{1}{2}(S^2/E)Al$

✦ ✦ ✦

IN applying this formula to the Reactive load, the mean area of the wire in the die $(A + a)/2$, is used to determine the mean unit stress. As an example, the computations involved in Determination No. 5, as scheduled in the table Fig. 1, are as follows:

✦ ✦ ✦

ALL computations are made for one hundred feet of wire, this being a convenient unit to use.

$A = (.0051 + .0041)/2 = .0046$ sq. in.
$l = 100' = 1200''$
$E = 30{,}000{,}000$ lbs. per sq. in.

✦ ✦ ✦

FOR the determination made with a 50% pull ratio:

(9) $S = 140/.0046 = 34{,}000$ lbs. per sq. in. (Effective Elastic Stress)

✦ ✦ ✦

FOR the determination made with a 31% pull ratio:

(10) $S = 810/.0046 = 17{,}000$ lbs. per sq. in. (Effective Elastic Stress)

✦ ✦ ✦

Draft made with 50% pull ratio

(11) $R = \frac{1}{2}(34{,}000^2/30{,}000{,}000).0046 \times 1200$
$R = \frac{1}{2}(39)5.52$
$R = 108$ in. lbs. $= 9$ ft. lbs.

✦ ✦ ✦

Draft made with 31% pull ratio

(12) $R = \frac{1}{2}(17{,}000^2/30{,}000{,}000).0046 \times 1200$
$R = \frac{1}{2}(10)5.52$
$R = 28$ in. lbs. $= 2.33$ ft. lbs. (this is reported as 3 ft. lbs. in the table)

✦ ✦ ✦

ALL of the values for the work of elastic resilience given in the table Fig. 1, were computed in this manner.

✦ ✦ ✦

ALL of the values for the effective plastic stress given in the table Fig. 1, were computed in the same manner as previously described for computation of the conventional mean yield point.

✦ ✦ ✦

EQUATIONS (8) and (9) give the effective elastic stresses, respectively, for the drafts made with a 50% and 31% pull ratio in Determination No. 5, as reported in the table Fig. 1. It will be noted that the sum of the effective plastic stress and the effective elastic stress is equal to the mean yield point of the wire.

✦ ✦ ✦

THIS is true in the case of every determination which has been made, within the limits of the accuracy of the observations. It will be noted that the stress acting upon the wire in the die is equal to the mean yield point of the wire, regardless of the method of drawing which is used.

✦ ✦ ✦

NEXT to be considered is the work which must be performed on the wire in order that the stress in the wire in the die shall reach the mean yield point.

✦ ✦ ✦

IN all cases discussed, a length of wire equal to 100 ft. or 1200 in. will be considered, as this is a convenient unit to use.

✦ ✦ ✦

IN the case of conventional drawing this work, in foot pounds, is equal to 100 ft. times the die pull in pounds; and all of the conventional determinations reported in the table Fig. 1, are computed in this manner.

✦ ✦ ✦

IN the case of Reactive Drawing this computation is a little more complicated. The determination of this work is divided into two parts; just as the determination of the mean yield point is divided into two parts, as previously shown.

✦ ✦ ✦

THE part of this work which is determined from the die pressure (the plastic portion of the stress) is computed in exactly the same manner as the work of conventional drawing; 100 ft. times the die pressure.

✦ ✦ ✦

THE part of this work which is determined from the Reactive load (the elastic portion of the stress) is computed by the formula for resilience, as previously shown in the case of Determination No. 5, and reported in the table Fig. 1. Equations (10) and (11) give the resilience of the Reactive load for the determinations made with 50% and 31% pull ratios, respectively.

✦ ✦ ✦

THE total work of Reactive reduction is the sum of the work of the Reactive load (resilience) and the work of the effective plastic stress.

✦ ✦ ✦

IT will be noted that in every case the total work of Reactive reduction is appreciably less than the work of conventional reduction.

✦ ✦ ✦

THE next point to be considered is the amount of heat generated in the wire by the work of reduction which is done on the wire.

✦ ✦ ✦

THE principal limiting factor, in relation to the speed of drawing, is the heat generated in the wire; this is affected by all of the factors involved, reduction, friction and speed.

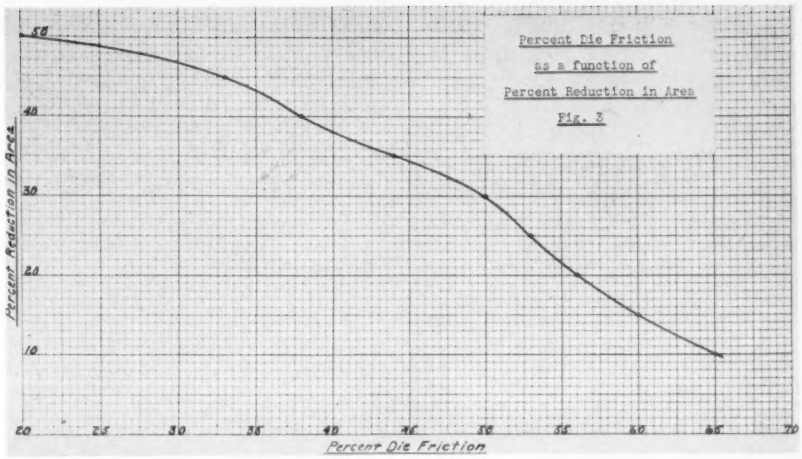
✦ ✦ ✦

IN order to determine wire temperatures accurately very elaborate and extremely delicate equipment is required. Determinations must be made under as nearly perfectly controlled conditions as possible as any change in air condi-

tion, air circulation, ambient temperature, or even in the barometer, will affect the accuracy of the results.

✦ ✦ ✦

TEMPERATURE. however, is an effect and not a cause in itself and is the direct result of the heat content of the wire. If a certain quantity of heat, measured in B.T.U. is generated in a wire, the wire will acquire a temperature which is directly proportional to the heat content of the wire and is independent of the manner in which this heat is generated. The temperature of the wire, at any instant, as measured by a thermometer, might be greater or less than that equivalent to the amount of heat generated in the wire, due to varying ambient conditions. It is therefore evident that as the heat generated in a wire can be determined rather precisely from the amount of work done on the wire, heat rather than temperature is a better yard stick to use for thermodynamic measurements.



WORK is transferred into heat by means of the constant known as the mechanical equivalent of heat. This constant was first determined by **Joule** as 772 ft. lbs. per B.T.U. It was again determined, at a later date, by **Rowland** as 778 ft. lbs. per B.T.U. and this latter quantity is generally used in thermodynamic computations. **Rowland's** equivalent was used to determine the amounts of heat given in the table Fig. 1.

✦ ✦ ✦

IN every determination the amount of heat generated in the wire by Reactive Drawing is definitely less than that generated by conventional drawing. As a corollary, the temperature of a Reactively drawn wire will be lower than that of a wire conven-

FIG. 4

Determination Number	Percent Reduction	Type of Drawing	Percent Friction	Effective Plastic Stress, lbs. per sq. in.	Reactive Friction, lbs. per sq. in.	Mean Yield Point, lbs. per sq. in.	Conventional Friction, lbs. per sq. in.	% Reduction in Friction	% Reduction in Total Heat (From Table 1)
		Conv.				143,000	74,000		
1	27%	50% R.	52%	83,000	43,000			42%	44%
		31% R.		107,000	56,000			24%	25%
		Conv.				163,000	80,000		
2	31%	50% R.	49%	100,000	49,000			39%	38%
		31% R.		133,000	65,000			19%	23%
		Conv.				84,000	48,000		
3	19%	50% R.	57%	56,000	32,000			33%	32%
		31% R.		70,000	40,000			17%	16%
		Conv.				102,000	53,000		
4	27%	50% R.	52%	72,000	37,000			30%	29%
		31% R.		.....	.....			...	...
		Conv.				99,000	56,000		
5	19%	50% R.	57%	61,000	35,000			37%	38%
		31% R.		78,000	44,000			21%	21%
		Conv.				101,000	55,000		
6	24%	50% R.	54%	67,000	36,000			35%	35%
		31% R.		82,000	44,000			20%	19%
		Conv.				46,000	26,000		
7	19%	50% R.	57%	.....				...	...
		31% R.		39,000	22,000			15%	14%

Note: In the column headed "Type of Drawing", 50% R. and 31% R. stands for Reactive Drawing with 50% and 31% pull ratio, respectively.

tionally drawn through the same reduction, with the same lubricant, at the same speed, and under the same ambient conditions.

✦ ✦ ✦

IT should be noted that the amount of work done on the wire by the Reactive load is so small that the equivalent heat generated is inconsiderable. For practical purposes it is sufficiently accurate to neglect the work of the Reactive load. Also, when the stress is removed from the wire, the work of the Reactive load is returned to the system and the wire has the capacity to absorb an equivalent amount of heat. Under this latter condition, the wire is doing work instead of having work done upon it.

✦ ✦ ✦

THE external factor which contributes most to the heating of the wire during reduction is the die friction; and it is quite apparent that it is the Reactive load which causes the reduction in this friction. The Reactive load, being a direct pull on the wire, also produces a portion of the mean yield point stress in the die.

✦ ✦ ✦

THE curve Fig. 3, gives the portion of the die load which is made up of friction. (This curve is plotted from the same data as the **Lewis** curve Fig. 2, but plotted as percent die friction, instead of friction factor, against percent reduction in area and was also determined by **Mr. Kenneth B. Lewis.**

✦ ✦ ✦

FROM this curve, and the stresses given in the table Fig. 1, the tabulation Fig. 4, results. It will be noted that there is an appreciable reduction in friction.

✦ ✦ ✦

AN examination of the table Fig. 4, will show that the percent reduction in friction equals, very closely, the percent reduction in total heat reported in the table Fig. 1, and the table Fig. 5 shows that the percent reduction in friction also equals, very closely, the percent reduction in power.

✦ ✦ ✦

IT has been demonstrated, experimentally, that the die pressure is independent of the speed of drawing and this, in turn, demonstrates that the amount of friction is independent of the speed of drawing; which was to be expected from the laws of friction.

✦ ✦ ✦

THE amount of heat generated is directly proportional to the work performed and as the die pressure is constant the amount of heat generated is directly proportional to the speed.

✦ ✦ ✦

FROM the preceding data, the following observations may be deduced:

(a) Reactive drawing decreases both the die friction and the work of reduction.

(b) The decrease in friction and in the amount of heat generated is of the same order as the saving in the power required to draw.

(c) These savings are independent of the speed of drawing.

Next to be considered is the effect of using different amounts of Reactive load.

✦ ✦ ✦

THE diagram Fig. 6, shows the relationship existing between Total Pull, Reactive Die Pressure and Reactive Load, (or pre-stressing), each expressed as a percentage of the conventional die pressure, for various percentages of Pull Ratio. This diagram is laid out from two different sets of experiments on widely divergent materials and should therefore be representative. The solid portions of the curves are plotted from determinations made on an 18-8 stainless steel; the portions in dash lines are plotted from determinations made on a .02 C. steel.

✦ ✦ ✦

AN examination of this diagram discloses the following facts:

(a) As the Reactive load (or pre-stressing) is increased, the Reactive die pressure diminishes, but not at the same rate, nor at a constant rate.

(b) A critical point exists at 50% pull ratio.

(c) Below this critical point the Reactive die pressure is greater than the Reactive load, while above this critical point the Reactive die pressure is less than the Reactive load.

FIG. 5

Determination Number	Percent Reduction	Type of Drawing	Total Work of Reduction, ft. lbs. per 100' of Wire (From Table 1)	Horse Power at 100' per Min.	% Reduction in Power	% Reduction in Friction
		Conv.	12,000	.364		
1	27%	50% R.	7,007	.212	42%	42%
		31% R.	9,003	.273	25%	24%
		Conv.	9,800	.297		
2	31%	50% R.	6,700	.182	39%	39%
		31% R.	8,003	.242	19%	19%
		Conv.	19,400	.588		
3	19%	50% R.	12,806	.388	34%	33%
		31% R.	16,002	.485	17%	17%
		Conv.	12,800	.388		
4	27%	50% R.	9,203	.273	30%	30%
		31% R.	....	...	...	...
		Conv.	22,800	.691		
5	19%	50% R.	14,009	.424	39%	37%
		31% R.	17,803	.538	22%	21%
		Conv.	20,000	.606		
6	24%	50% R.	13,209	.400	34%	35%
		31% R.	16,207	.486	20%	20%
		Conv.	10,500	.318		
7	19%	50% R.	....	...	...	...
		31% R.	9,001	.272	14%	15%

Note: In the column headed "Type of Drawing", 50% and 31% R. stand for Reactive Drawing with 50% and 31% pull ratio, respectively.

(d) The maximum total Reactive pull exists at 50% pull ratio.

(e) It is possible to develop a total Reactive pull which is less than the conventional pull required to make the same reduction.

✦ ✦ ✦

IN further consideration of this latter fact, reference is had to the curve Fig. 7, which gives the pull and load conditions existing during the drawing of a .02 C. steel wire both conventionally and Reactively. It will be noted that between a total reduction of 66½% and 81% the values of the total Reactive pull are less than of the conventional pull required to accomplish the same reduction. Between 81% total reduction and 94½% total reduction the reverse is true, but at 94½% total reduction a second crossing of the curves of total Reactive pull and conventional pull is noted.

✦ ✦ ✦

WHY this condition exists, I am not yet prepared to say: this condition never occurs with a pull ratio less than 50% and is produced by a critical combination of pull ratio and reduction in area; it is also a function of the material being drawn. It can be taken advantage of commercially, in certain drafts, by properly proportioning reductions and pull ratios.

✦ ✦ ✦

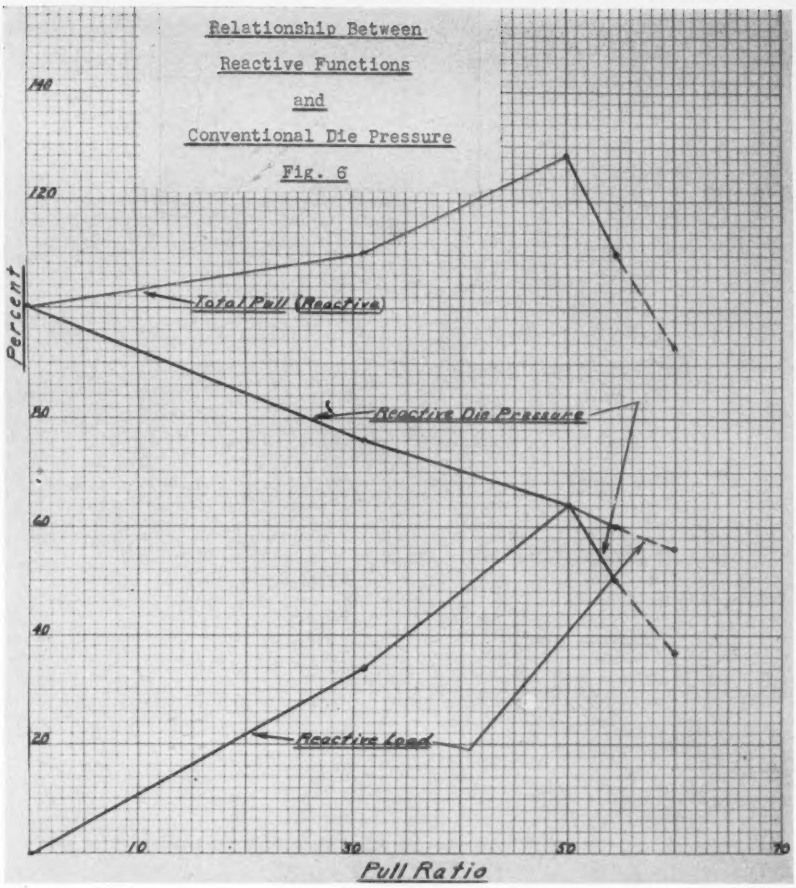
THE physical characteristics of a wire are profoundly affected by the amount of Reactive load or pre-stressing applied to the wire during drawing, and here again is a contradiction of the orthodox concepts of metallurgy.

✦ ✦ ✦

FIGS. 8, 9 and 10 are diagrams showing the comparative tensile strengths of an 18-8 stainless steel wire drawn both Reactively and conventionally through the same series of reductions.

✦ ✦ ✦

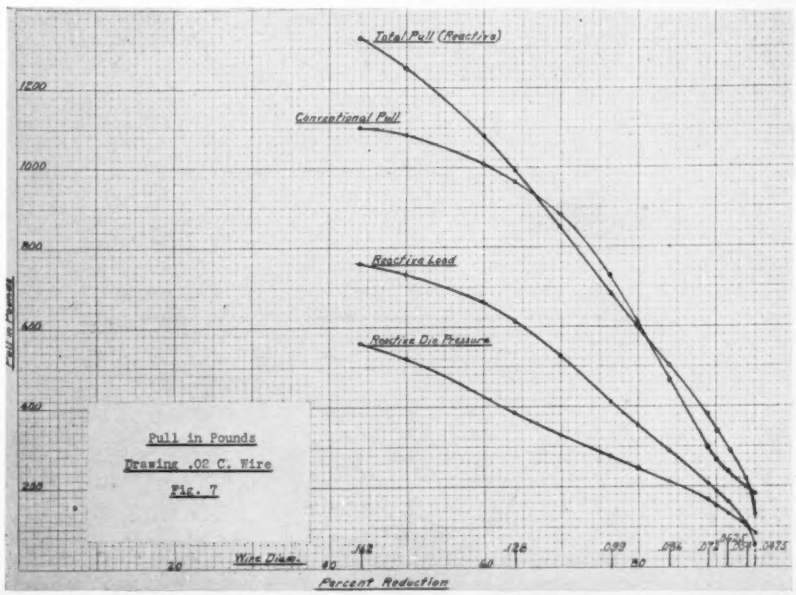
IT will be noted that for pull ratios below the critical value of 50%, there appears to be a critical point at about 36% total reduction, below which the tensile curves run rather closely together. Above this point, the Reactively drawn wire has the greater tensile strength.

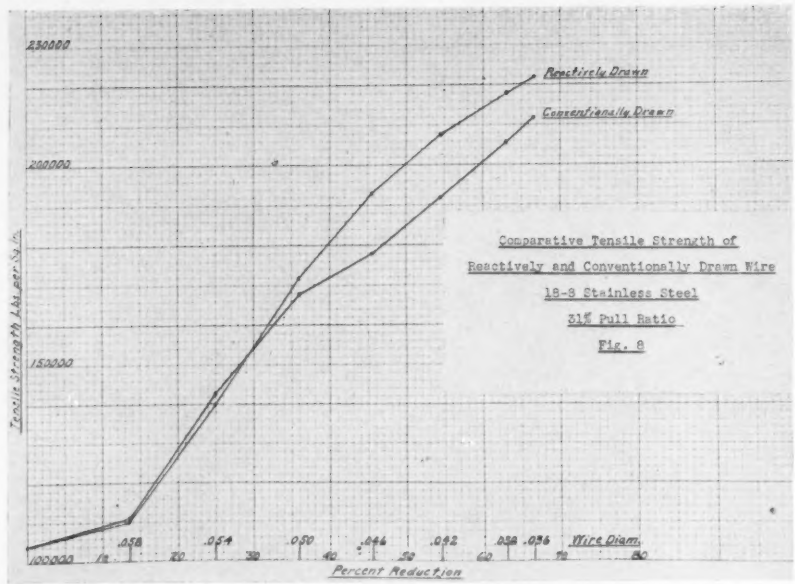


FOR pull ratios of over 50% this critical point does not exist and the entire tensile curve is raised, as shown by Fig. 10.

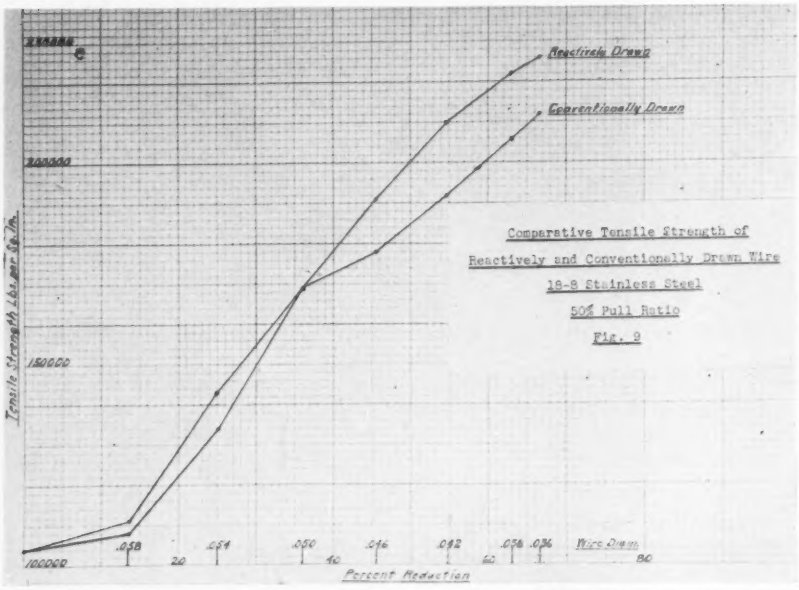
✦ ✦ ✦

FIGS. 11 and 12 give the same information for a .60 C. Swedish steel wire. It will be noted that the same critical point as to tensile strength exists as in

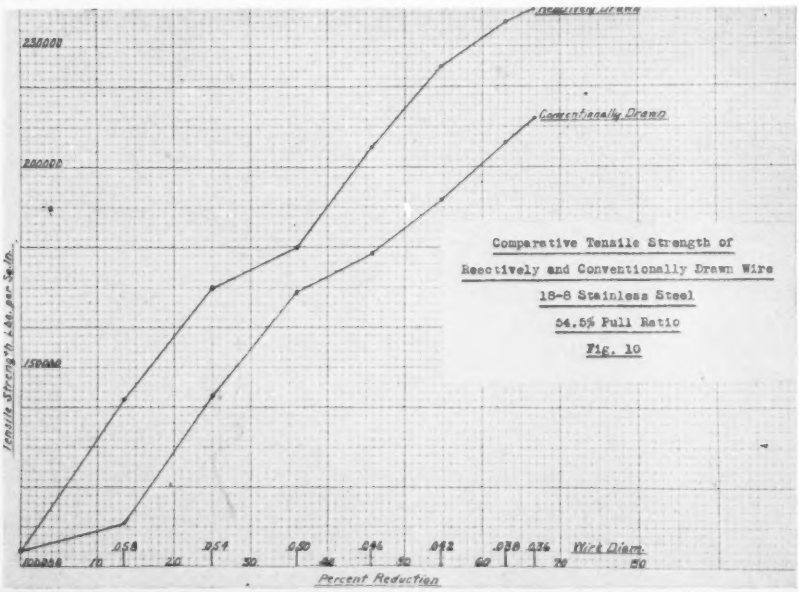




Comparative Tensile Strength of
Reactively and Conventionally Drawn Wire
18-8 Stainless Steel
31% Pull Ratio
Fig. 8



Comparative Tensile Strength of
Reactively and Conventionally Drawn Wire
18-8 Stainless Steel
50% Pull Ratio
Fig. 9



Comparative Tensile Strength of
Reactively and Conventionally Drawn Wire
18-8 Stainless Steel
54.5% Pull Ratio
Fig. 10

the case of the stainless steel wire, but in this case the point appears at a total reduction of about 54%.

✦ ✦ ✦

FIG. 13 is a torsion diagram for this same wire. The 31% pull ratio gives the highest torsions as well as the highest tensile strength and there appears to be no relation between the critical reduction, as regards tensile strength, and the number of torsions.

✦ ✦ ✦

FIGS. 14 and 15 give the same information for a chrome-vanadium steel as used in spring making. Here there is a critical point as to tensile strength at about 73% total reduction and a spreading out of the curves both below and above this point.

✦ ✦ ✦

FIG. 16 is a torsion diagram for this same wire. Here again there is no apparent relation between the critical reduction, as regards tensile strength, and the number of torsions.

✦ ✦ ✦

THE determinations reported in Figs. 14, 15 and 16 were made for a well-known spring manufacturer and the wire returned to him after drawing for the purpose of making springs. This manufacturer reported that the wire drawn with a 31% pull ratio made perfect springs with no variation in free length and no variation in diameter. All other wires tested made springs with some variation in free length and diameter, the wire drawn with a 50% pull ratio (at the critical point) being second best and the conventionally drawn wire the poorest.

✦ ✦ ✦

IN the following paragraphs the effects of Reactive Drawing have been classified and set down under two general headings; first, the effect of Reactive Drawing on the mechanics of drawing wire; second, the effect of Reactive Drawing on the metallurgy of drawing wire. Under these two headings the effects of the facts and data brought out in the preceding paragraphs will be discussed.

✦ ✦ ✦

The Effect on the Mechanics of Drawing Wire

BY the term **"mechanics of drawing"**, is meant die life, power

consumption, speed of drawing and production.

✦ ✦ ✦

Die Life

AS has been shown, the primary effect of Reactive Drawing is to reduce the die friction and therefore the die pressure and experimental determinations have shown that a reduction in friction of from 30% to 40% and more, is entirely practical and can be expected.

✦ ✦ ✦

BECAUSE of the tremendous pressures existing between the wire and the wall of the die, die friction is in a class by itself. It most emphatically does not follow the well known laws of the friction of lubricated surfaces and, strange as it may seem, follows broadly the laws relating to the friction of dry, unlubricated surfaces with certain exceptions. The friction varies not only with the total pressure between the die and the wire, but also with the total area of contact, since the total pressure is a function of the total area.

✦ ✦ ✦

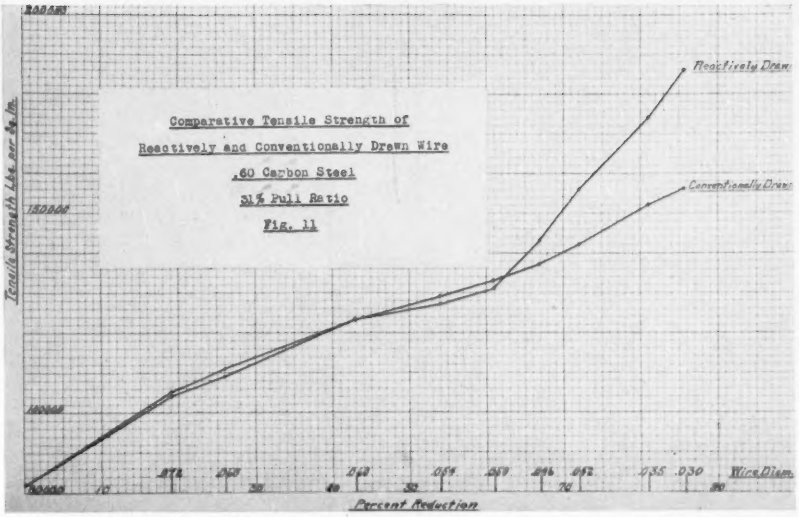
FROM the preceding data it would appear, at first glance, that the effect of Reactive Drawing on die life would be to increase the life of the die an amount, in percent, equal to the percent decrease in friction; because of the reduction in pressure between the rubbing surfaces. This, however, is not the case. The die life is increased a greater amount than the friction is decreased. The reason for this is not clear but it is not improbable that the coefficient of friction may be affected due to the large decrease in pressure in the die cone. This point merits further investigation.

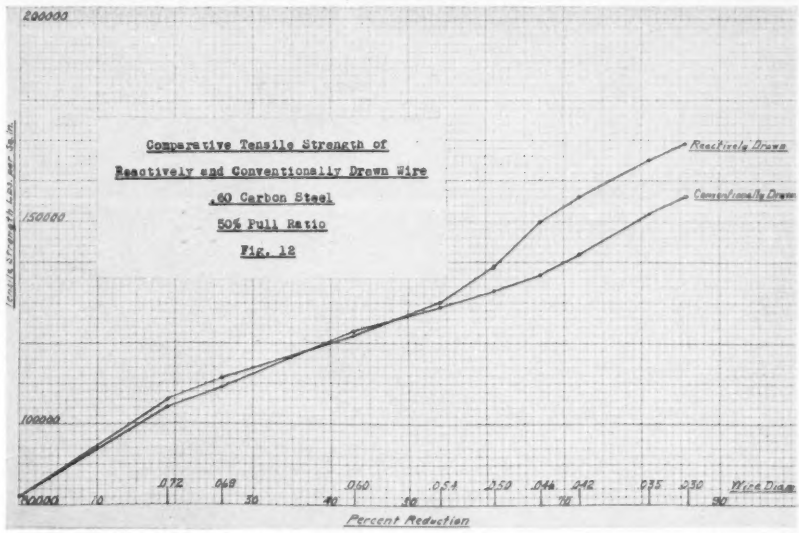
✦ ✦ ✦

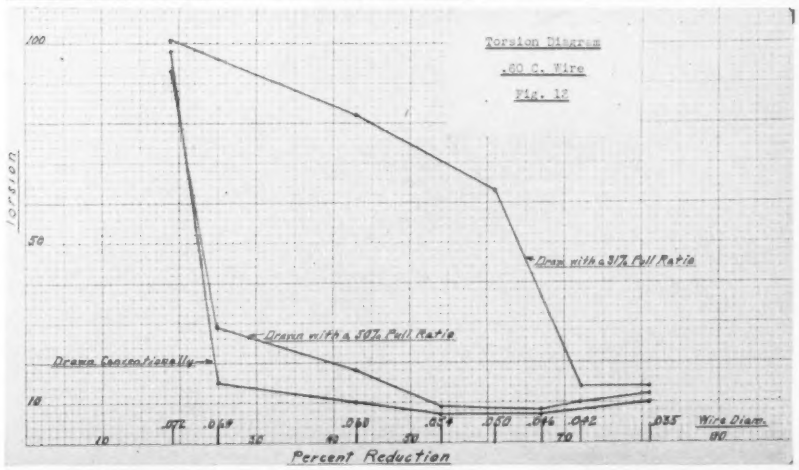
UNDER the conditions of Reactive Drawing the die is operating under a reduced total pressure, and also under a reduced unit pressure as the area of contact remains the same. It is also operating with a reduced percentage of friction.

✦ ✦ ✦

THIS latter indicates that, when necessary, light reductions may be made Reactively without incurring excessive die wear.

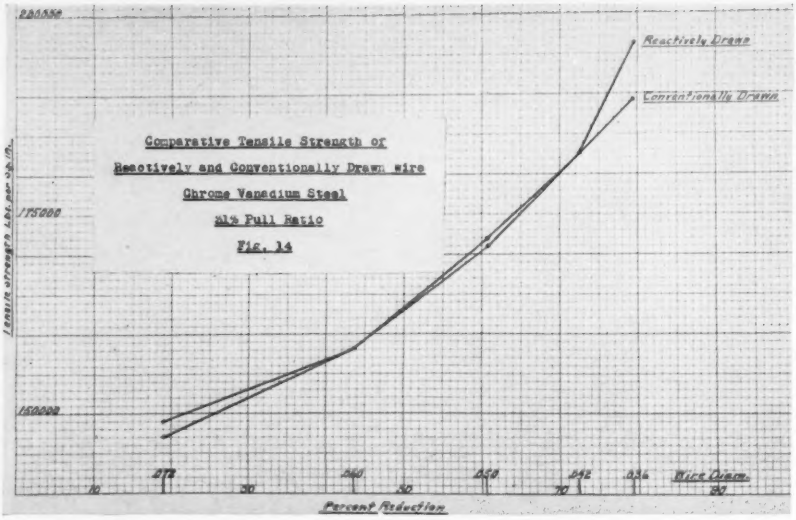


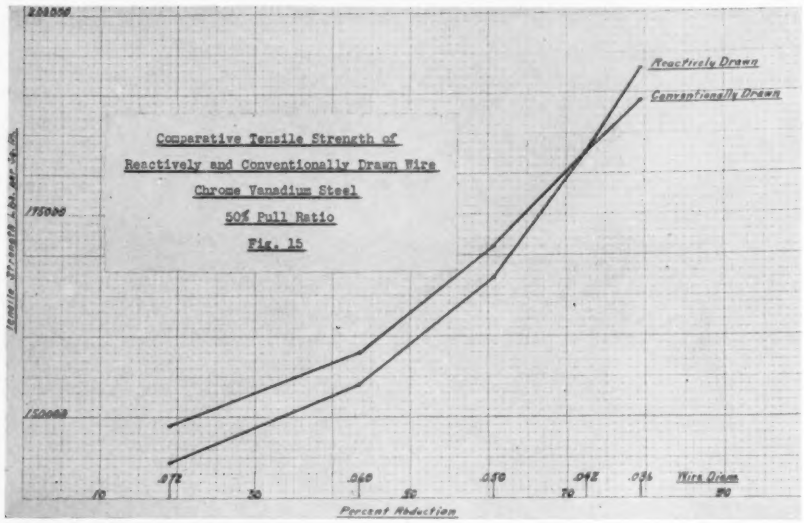


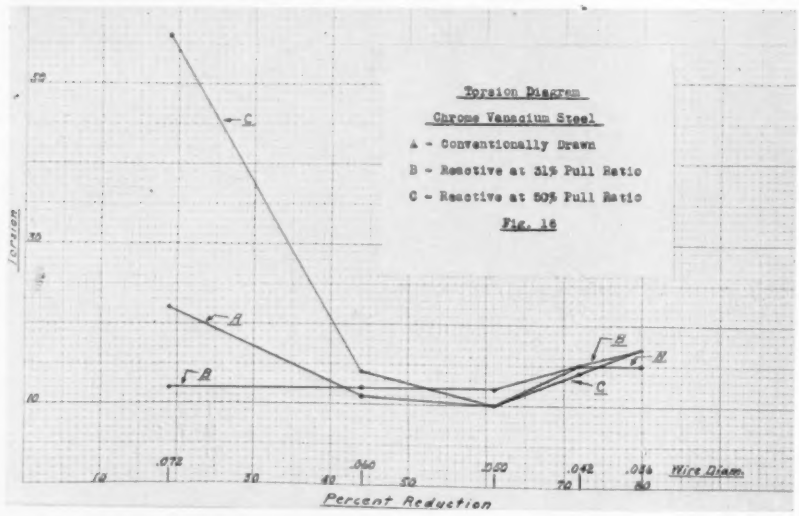


BECAUSE of the great number of investigations which had to be made, there was no opportunity to operate continuously over long periods of time and determine actual die life experimentally.

THE question of lubrication under Reactive conditions, is one to be seriously considered both from a quantitative as well as a qualitative standpoint and here is a very broad field for further in-







vestigation with profit. As might have been expected, wire Reactively drawn carries a heavier film of lubricant than conventionally drawn wire and this is evident from a visual examination alone.

IT is hardly necessary to point out that this condition simplifies greatly the problem of finish on the wire and at the same time permits greater latitude in the finish that can be secured with any type of lubricant.

✦ ✦ ✦

IT is well known that a die with a small included angle wears more slowly than one with a large angle, but the use of small die angles has been limited because of the increase in friction which the small angle produces.

✦ ✦ ✦

REACTIVE Drawing makes it possible to decrease the die angle to the point where the resulting friction is equal to that in a larger angle die operating under conventional conditions. With such a die, die life would still be increased because although the friction would be the same as under conventional conditions, the slow wearing effect of the small angle is present. Die manufacturers could profitably carry out investigations on the optimum combination of die angle and friction factor for maximum life under Reactive conditions.

✦ ✦ ✦

Power Consumption

POWER consumption is reduced by Reactive Drawing in direct proportion to the reduction in friction as shown by the tables Figs. 4 and 5.

✦ ✦ ✦

IT is important not to confuse reduction in power with increase in die life, because although the reduction in power is due primarily to the reduction in the friction which must be overcome by an expenditure of power, the die life is increased not only on account of the reduction in friction, but for other reasons as well which are not reflected in the power requirements.

✦ ✦ ✦

Speed of Drawing and Production

PRODUCTION is of course a direct function of the speed of drawing and this in turn is a corollary to the die life.

✦ ✦ ✦

THE speed of drawing can be increased to the point where

the amount of heat generated is equal to that generated under the conditions of conventional drawing, assuming this latter to be the maximum amount which can be tolerated.

✦ ✦ ✦

THIS again is not directly proportional to the reduction in friction because there is a further reduction in the heat generated in the wire caused by crystal deformation. This latter heat has not been measured, but the reduction in this heat is of the order of the difference between the mean yield point and the effective plastic stress as given in the table Fig. 1. Here again is a very interesting subject of investigation which has considerable practical value, especially in continuous drawing.

✦ ✦ ✦

The Effect of the Metallurgy of Drawing Wire

BY the term **"metallurgy of drawing"** is meant the control of those properties of a wire which are secured, either directly by drawing, or by a combination of drawing and heat treatment.

✦ ✦ ✦

THE more important of these properties are tensile strength and resistance to torsion. The heat treatments to be considered, as affecting these properties, are patenting and annealing.

✦ ✦ ✦

Tensile Strength

FOR any given reduction, or series of reductions, the tensile strength can be varied within wide limits, by applying different amounts of Reactive load, or prestressing.

✦ ✦ ✦

ON a continuous machine, wire of differing tensile strength can be produced through the same set of reductions by simply varying the amount of Reactive load applied to each draft.

✦ ✦ ✦

THE higher Reactive tensile strengths are secured without additional loss in ductility, as is shown by torsion tests and by the fact that wire can be drawn farther Reactively than conventionally.

✦ ✦ ✦

Torsion

THE resistance of a wire to torsion can be varied with the tensile strength by the application of different amounts of Reactive load, the reduction remaining constant.

✦ ✦ ✦

IN practically every case studied, especially with patented wires, the torsion resistance increases with the tensile strength.

✦ ✦ ✦

THE above conditions regarding physical properties, are to be expected because of the nature of Reactive Drawing. When drawing Reactively, the crystal structure of the wire is permitted to take a preferred orientation under controlled conditions of plastic stress. The work done upon the crystal grains by the Reactive load (the elastic resilience, as previously explained) because of its inherent elastic nature, produces little permanent effect upon the structure of the wire. By varying the Reactive load or prestressing the amount of active plastic stress is also varied, which latter stress produces permanent deformation and imparts the characteristics of the drawn wire.

✦ ✦ ✦

IT is expected that the effects of aging on Reactively drawn wire will be different from the effects on conventionally drawn wire.

✦ ✦ ✦

Patenting

BECAUSE of the ability to control tensile strength through the application of Reactive load or pre-stressing, the number of patentings required to draw a given wire a certain total reduction with a predetermined tensile strength, can be reduced.

✦ ✦ ✦

THIS also points to the probability of being able to use a lower carbon steel for a given total percent reduction in order to secure a predetermined tensile strength.

✦ ✦ ✦

Annealing

THE table Fig. 17 shows the comparative effects of applying equal amounts of Reactive load or pre-stressing to both an annealed and a patented wire. The wires were reduced an equal amount and drawn through the same series of reductions.

✦ ✦ ✦

AS was to be expected, the Reactive load had a greater effect on the tensile strength and torsions of the annealed wire, because of the difference in the crystalline structure of the two wires.

✦ ✦ ✦

THE table Fig. 1, gives the relative amounts of elastic stress and plastic stress existing in the various wires in the die when they were drawn. It also shows that, in the case of Reactive Drawing, the mean yield point is arrived at with considerably less work than in the case of conventional drawing.

FIG. 17

Method of Drawing	.60 C. Wire Drawn 85.8% Total Reduction to .030" dia.							
	Patented				Annealed			
	Tensile, p.s.i.	% Increase	Torsion	% Increase	Tensile, p.s.i.	% Increase	Torsion	% Increase
Conventional	233,000		37		156,000		9	
R. 50% P.R.	237,000	1.7	43	16.2	169,000	8.3	14	55.6
R. 31% P.R.	262,000	12.5	43	16.2	186,000	19.2	14	55.6

Note: In the column headed "Method of Drawing", R. 50% P.R. and R. 31% P.R. stand for Reactive Drawing, with 50% and 31% pull ratio, respectively.

CONSIDERING again Determination No. 5, which has been used throughout as an example, the mean yield point is arrived at, conventionally, with a plastic stress of 99,000 lbs. per sq. in. while, in the case of Reactive Drawing, this stress amounts to 61,000 lbs. per sq. in. and 78,000 lbs. per sq. in., with pull ratios of 50% and 31%, respectively. The elastic stresses accompanying these plastic stresses are also reported in the table, but their effect on the wire is removed when those stresses are removed because of the elastic nature of these stresses and the consequent elastic nature of the strains which they produce.

✦ ✦ ✦

IT is therefore the plastic portion of the stress in the die which leaves its imprint on the crystalline structure of the wire, the effects of which are to be removed by annealing.

✦ ✦ ✦

BECAUSE in Reactive Drawing the plastic stress existing in the wire during reduction is so much less than that existing under conventional conditions of drawing, the resulting permanent effect on the crystalline structure of the wire is proportionally modified.

✦ ✦ ✦

THIS is borne out by the fact that, with Reactive Drawing, an increase in tensile strength during drawing, due to cold working, is accompanied by an increase in the number of torsions the wire will withstand before failure.

✦ ✦ ✦

HERE is the unusual condition of a wire which has been subjected to a less amount of cold work (if cold work be measured in terms of applied stress) having a higher tensile strength than the same wire when subjected to a greater amount of cold work.

✦ ✦ ✦

IF cold work be measured by reduction in cross sectional area the condition is even more unusual in that the same wire under the same condition of cold work has two differing values of its tensile strength. This is, of course, the "reductio ad absurdum" and indicates that a more rational measure of cold work is the applied stress and not the reduction in area.

✦ ✦ ✦

THE apparent anomaly, however, does not end here. The wire with the higher tensile strength will also withstand the greater number of torsions, as shown by the table Fig. 17.

✦ ✦ ✦

A TORSION test is not the proper manner by which to determine ductility; it is, however, broadly speaking, a measure of ductility in that the more ductile wires give the higher torsion results.

✦ ✦ ✦

THE factors which operate to increase tensile strength during cold working tend also to reduce the ductility of the wire and, in consequence the number of torsions it will withstand. We have, however, in Reactively drawn wire a condition in which the tensile strength and also the torsions are increased by cold working and this has been shown to occur in substantial amount with both patented and annealed wire.

✦ ✦ ✦

A TORSION test is actually a measure of the elongation of the outer fibres of a wire. That being the case, it is strongly indicated that

The distribution of cold work over the cross section of a wire is, at least, equally as important, in determining the characteristics of the wire, as the actual amount of cold work. In other words, a smaller amount of cold work uniformly distributed over the cross section of a wire is more effective than a greater amount of cold work which has been confined principally to the central fibres of the wire.

✦ ✦ ✦

THE above points to the probability of being able to anneal Reactively drawn wire with a much shorter "soak" at the annealing temperature than is possible today.

Note: In reference to cold work, reference is made to an article by the author on the crystal theory of Reactive Drawing which appeared in WIRE AND WIRE PRODUCTS, May 1939. Experiments made by others on non-ferrous wires, the results of which will be published at a later date, have shown this theory to be substantially correct.

SUCH a procedure will not only appreciably reduce the cost of annealing but will also decidedly reduce the danger of decarburization and the complete spheroidizing of cementite.

✦ ✦ ✦

WE have given here the salient facts regarding the principles of Reactive Drawing, together with examples of the results secured by applying these principles to the drawing of various kinds of wire.

✦ ✦ ✦

IT is evident that a new field of investigation has been opened up upsetting, in some instances, the ordinary conceptions of physical metallurgy and giving new light on others. It is the writer's considered opinion that by the use of Reactive Drawing methods the true nature of the mechanism of cold work and its control may be determined.

✦ ✦ ✦

REACTIVE Drawing is no longer in the experimental stage. Production equipment of both single hole and continuous type is completely designed for a wide range of wire sizes and installations suited to any mill requirements can now be made.

✦ ✦ ✦

REACTIVE Drawing methods are applicable to most wire mills and may be used for widely divergent reasons, or a combination of several reasons. If the product is of a highly competitive nature and costs are paramount, Reactive Drawing will lessen the cost of dies, lubricant, power and heat treatment and at the same time substantially increase production. If the product is specification and specialty wire where quality is of primary importance, Reactive Drawing will improve the quality of the product, increase production and make it possible to draw alloy and stainless steels accurately and economically.

✦ ✦ ✦

FOR airplane construction, and this is especially significant during the present armament programme, a superior high strain airplane wire can be produced Re-

(Please turn to Page 635)

A *Simple Statement of Simple Fact:*

The wire industry needed improved methods for zinc-coating wire because:

1. Coating requirements were continually being raised.
2. The older methods had reached their limit.

Electro-galvanizing supplied this need by providing:

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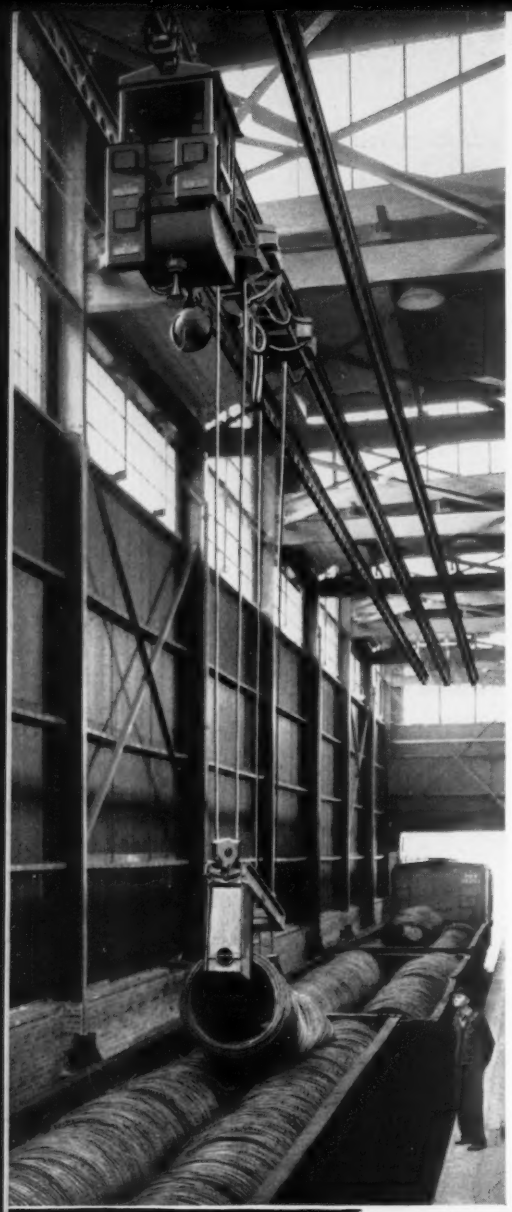

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The list of Cleveland Tramrail users in the Wire & Wire Products Industry is growing larger every year because the many installations serving this important field have proven convincingly that great savings can be made by handling the materials overhead.

The Cleveland Tramrail hairpin-hook system has greatly lowered shipping and rod storage costs. Up to eleven 300 lb. bundles of rod can be picked up, transported and discharged by the Tramrail cab operator alone.

Approximately 40% of the basic rod production of this country is stored via Cleveland Tramrail. Another 10% is handled in the plants of manufacturers who purchase rod.

The hard work of block stripping has been greatly lightened with easily propelled cranes and carriers provided with fast, snappy hoists and rigid-arm push-button control.

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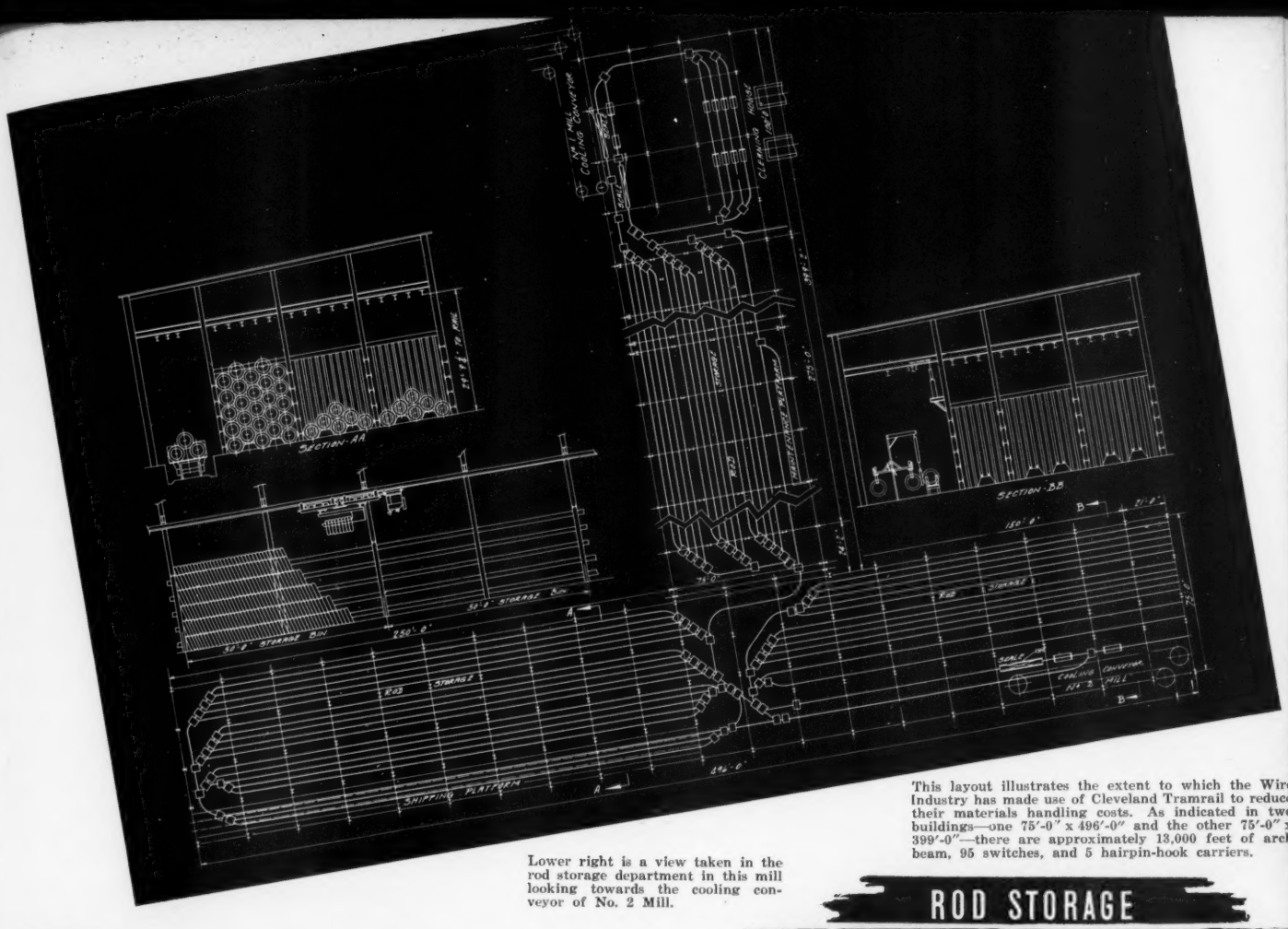
BLOCK STRIPPING

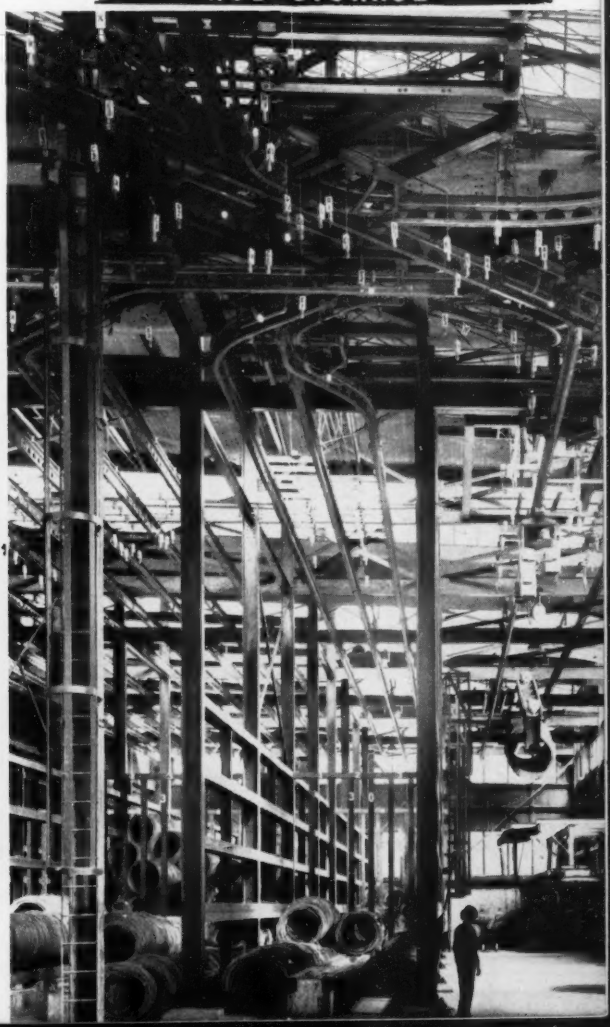


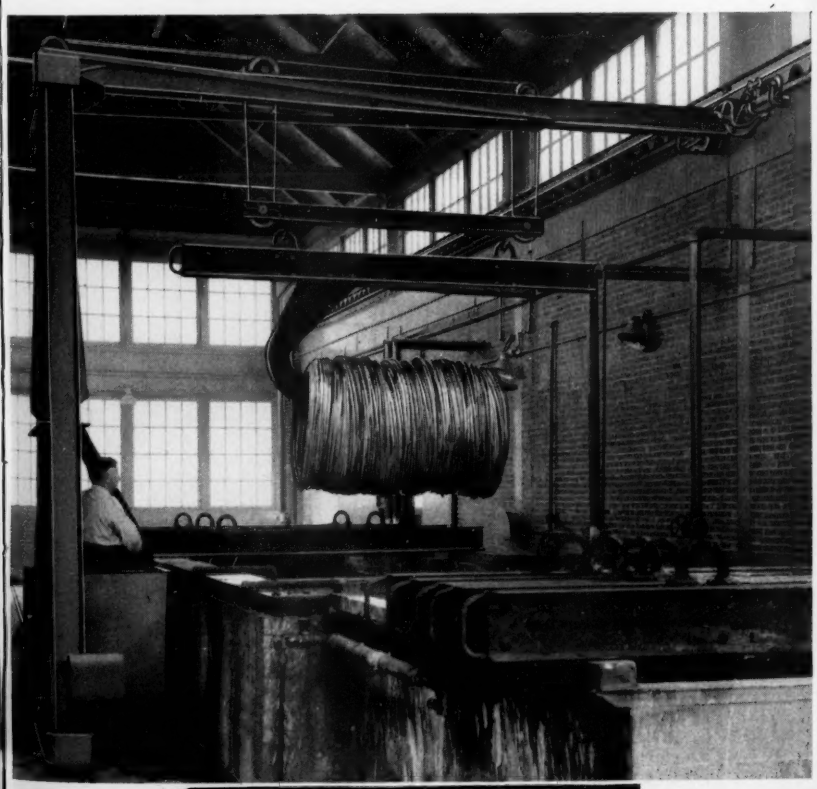
This layout illustrates the extent to which the Wire Industry has made use of Cleveland Tramrail to reduce their materials handling costs. As indicated in two buildings—one 75'-0" x 496'-0" and the other 75'-0" x 399'-0"—there are approximately 13,000 feet of arch beam, 95 switches, and 5 hairpin-hook carriers.

Lower right is a view taken in the rod storage department in this mill looking towards the cooling conveyor of No. 2 Mill.

TRAMRAIL

ROD STORAGE





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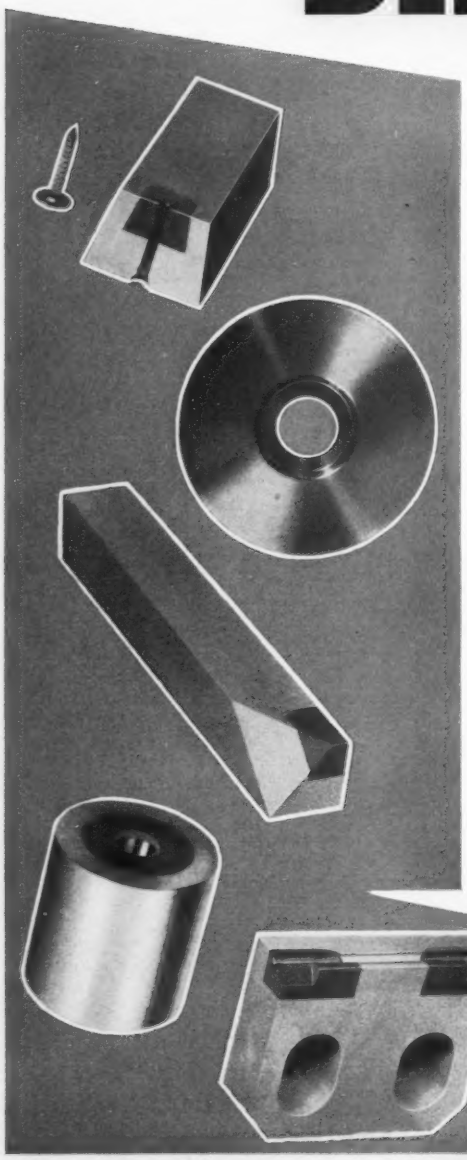

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Design and Operation of New Copper Wire Drawing Plant

By

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Development Engineer,
Western Electric Co.,
Baltimore, Md.

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Manager, Wire Mill,
Western Electric Co.,
Kearny, N. J.

Section I—Design and operation of high speed copper wire drawing machines was prepared by Mr. H. Blount. ✦ ✦ ✦

Section II — Equipping and operating a new wire mill was prepared by Mr. J. E. Wiltrakis.

SECTION I

Design and Operation of High Speed Copper Wire Drawing Machines

By H. Blount

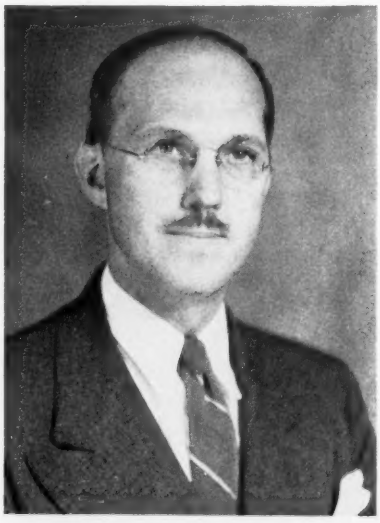
SUMMARY

This section covers the principal features in connection with the design of High Speed Wire Drawing Machines from which performances have been secured in accordance with our expectations. ✦ ✦ ✦ ✦

INDUSTRY has sought, by development and research, new machinery, tools, materials, and processes that would result in a greater production of goods of the same or even better quality than were produced by earlier methods. During the past three decades the demand for copper wire of all sizes has increased rapidly due to the wide-spread use of electric power, growth of the communication and signalling systems, introduction of radio, electrification of household appliances, and many other uses. Therefore, it was to be expected that the copper wire producers would desire to follow the lead set by other branches of industry.

✦ ✦ ✦

COPPER wire is used extensively in the making of facilities for communication purposes, the Bell Telephone System alone now using over 40 billion conductor feet per year. Most of this wire is concentrated in a few sizes: Nos. 16, 19, 22, 24, and 26 A.W.G. It is essential that this wire be of high quality with deviations in



J. E. WILTRAKIS

Associated with the Western Electric Company since 1920 on manufacturing capacity, cost reduction and plant location work at the Hawthorne (Chicago) Works and at 195 Broadway, New York City. Since 1937 has been in charge of engineering and operating the wire mill at Kearny, New Jersey.

H. BLOUNT

Associated with Western Electric Company for thirty-four years; has been engaged in manufacturing development for production of Copper Wire during past twenty-two years. At present in charge of development of high speed drawing of wire, with title of Manufacturing Engineer.

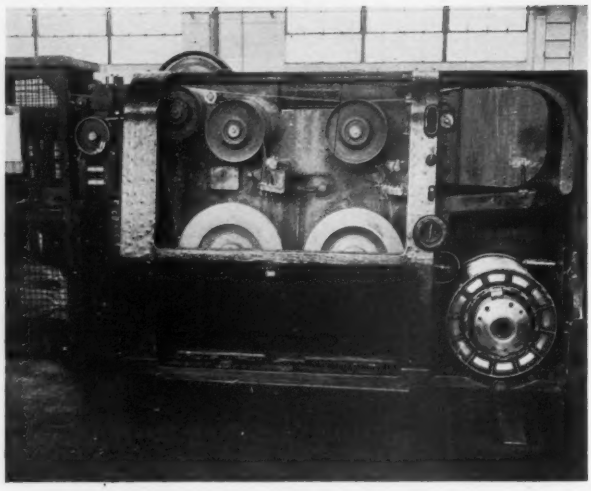


Fig. 1. No. 1 Wire Drawing Machine—Front View.

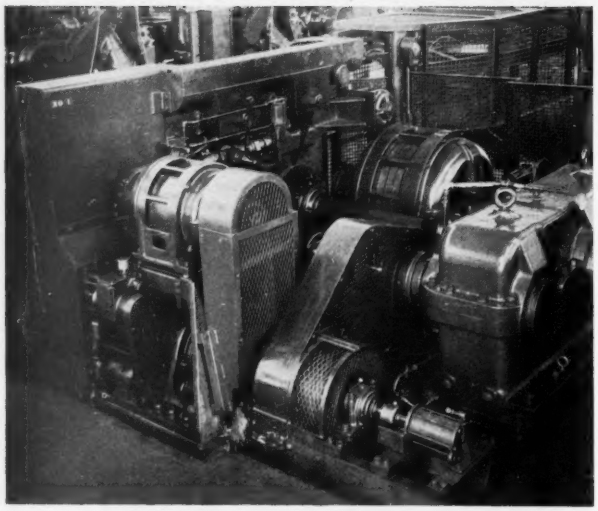


Fig. 2. No. 1 Wire Drawing Machine—Rear View.

diameter kept to the minimum so that the apparatus with which it is to be used will function properly.

✦ ✦ ✦

THE quantities of copper wire required by Western Electric, manufacturers of telephone cable and apparatus, had been increasing with each succeeding year, due to the rapid growth of the telephone system. A study made some years ago showed it would be economical for Western Electric to manufacture its wire, with the possibility of greater production by increasing the speed of drawing. The equipment provided at that time operated at speeds much higher than were then in general use, and the economies anticipated as a result of that study were fully realized.

A FEW years later the increased demands of the telehone system compelled consideration of expanding the wire making facilities, and it became evident that the speeds selected for the earlier installation were far from the ultimate at which wire could be drawn. Another development was started to determine a practical and economical speed for this expansion, resulting in the design, construction, and placing into operation of two sizes of wire drawing machines. One, which will draw rod to sizes as small as No. 16 A.W.G., is called the No. 1 and is of 10 die capacity, designed to operate at 6000 ft. per minute. Figures 1, 2, and 3 show the front and rear views of this machine. A second machine for redrawing to finished sizes No. 19 A.W.G., and smaller, is called the No. 2, and is of 12 die capacity, designed to operate at 10,000 and 12,000 ft. per minute. Figure 4 shows the front view of this machine. The design features outlined in the following text deal largely with the No. 2 Machine. Similar features are incorporated in the No. 1 Machines and reference is made to changes in design applicable only to that machine.

✦ ✦ ✦

CONTINUITY of operation is essential to higher drawing speeds, therefore, wire should be delivered in as large a unit package as practicable to secure this continuity with a minimum of scrap at the subsequent operations. Taking up wire in unit

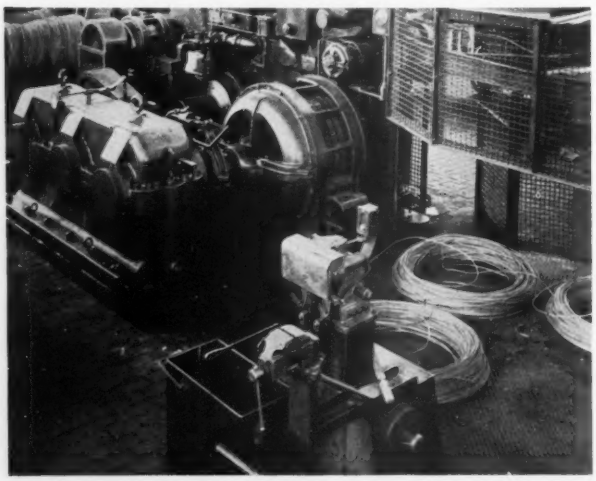


Fig. 3. No. 1 Wire Drawing Machine—Rear View

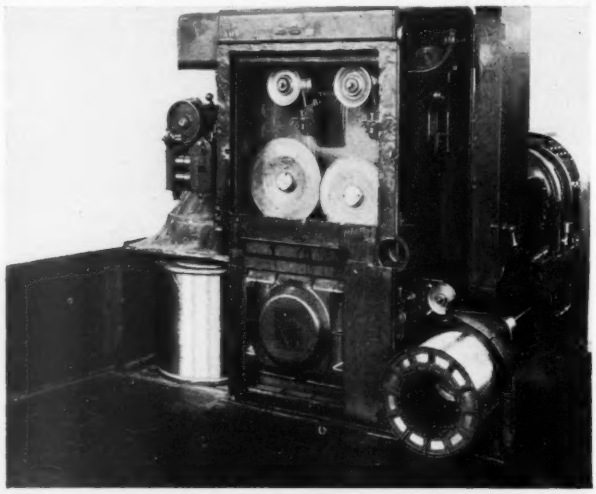


Fig. 4. No. 2 Wire Drawing Machine—Front View.

quantities as given in the A.S.T.M. Specification B-3 would limit the drawing speed below the possible maximum or cause interferences which would curtail production to some extent. A survey of the wire using equipment showed that reels as large as 18″ diameter could be used with a capacity of 400 lbs. of wire. This requires that a suitable drive be introduced on the reel takeups of the wire drawing machines to allow for gradual deceleration of speed as the reels fill up with wire.

✦ ✦ ✦

THE drive for the takeup reel should be capable of producing a uniform tension in the wire as taken up for its entire length on the reel. This tension must be controllable for the different sizes of wire, in order that after being annealed it can be easily removed at the subsequent operation.

✦ ✦ ✦

THE application of torque motors on several installations at Western Electric to secure uniform tension in the product being taken upon a reel had demonstrated this to be a very satisfactory form of takeup drive, as the motor will slow down with build up of wire on the reel without changing the wire tension to any appreciable extent. By changing the stator voltage of this type of motor, the torque can be regulated to give tension suitable for drawing the various sizes of wire within the capacity of the machine. By a proper selection of motors, variations in speed, without undue heating, can be obtained with a ratio of 1-1.8, which is of sufficient range to permit the use of reels of 400 lb. capacity.

✦ ✦ ✦

THE next step was to determine the maximum speed at which wire might be drawn and the speed at which it could be wound onto a reel. The maximum drawing speed was considered to be that speed where the stress set up by centrifugal force would equal the safe stress for copper of 25,000 lbs. per sq. in. A maximum drawing speed of 27,400 ft. per minute was determined by the following calculations:

Let W = Weight of drawn copper wire per cu. in. in lbs. = .3212 (A.I.E.E.)

V = Speed of wire in feet per second

G = Acceleration due to gravity.

1. Stress in Wire due to Centrifugal Force = S

$$S = \frac{12 \times W \times V^2}{G} = \frac{12 \times .3212 \times V^2}{32.2} = .1197\ V^2$$

2. Maximum Wire Speed Considering Only Stress Due to Centrifugal Force. The speed at which S would produce a stress of 25,000 lbs. per sq. in.

$$V = \frac{25000}{.1197} = 456 \text{ f.p.s. or } 27400 \text{ f.p.m.}$$

✦ ✦ ✦

WITH the possibility of a range of speed of 1 to 1.8, the stress set up in the reel rim at a wire speed of 27,400 f.p.m. would equal 62,000 lbs. per square inch when the wire is being taken up on the core of the reel, and the rim running 80% faster. Since this speed and resulting stress is above the safe limit for low carbon steel, a speed of 12,000 f.p.m. was selected which provided a factor of safety of approximately five to one. The stresses set up in the wire and reel rims for the various speeds are shown on diagram Figure 5.

✦ ✦ ✦

THE horsepower requirement of the torque motor for the takeup is made up of three components:

1. **Tension in Wire**
2. **Bearing Friction for Takeup**
3. **Reel Windage**

✦ ✦ ✦

WIRE should be taken up on the reel under sufficient tension to offset that created by centrifugal force. The tension in the wire resulting from centrifugal force is shown on diagram Figure 6, and is determined by taking the stress in copper wire at 12,000 ft. per minute, Figure 5, and multi-

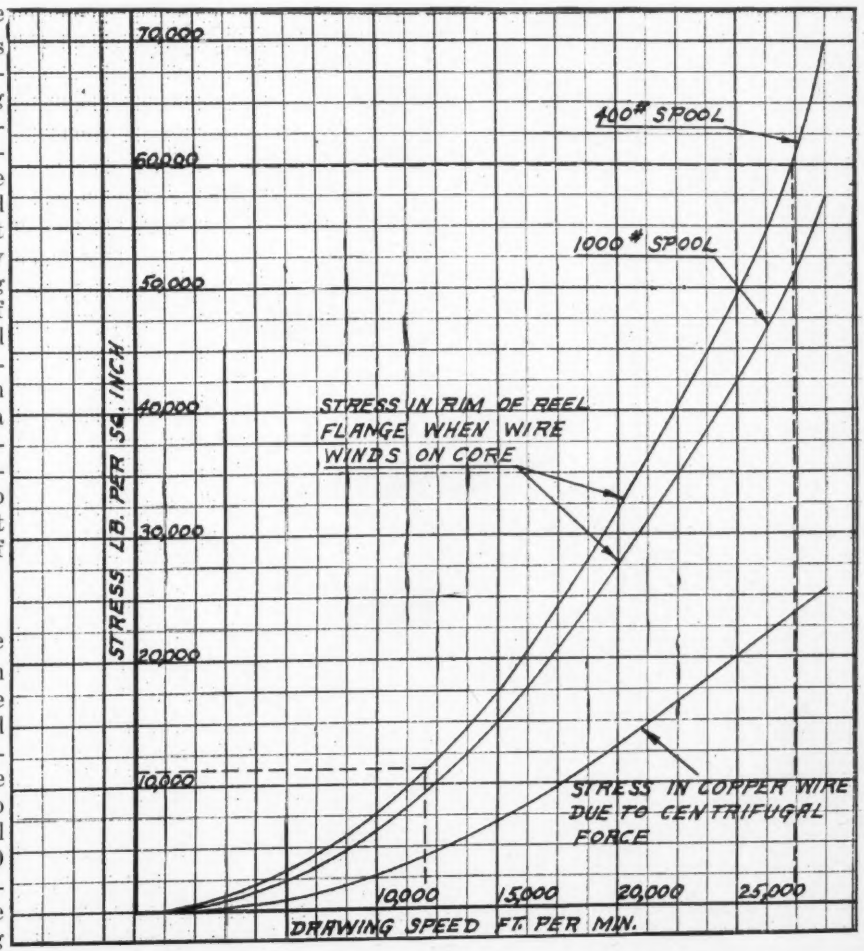


Fig. 5. Stresses Produced in Wire and Takeup Reel at Various Wire Drawing Speeds. ✦

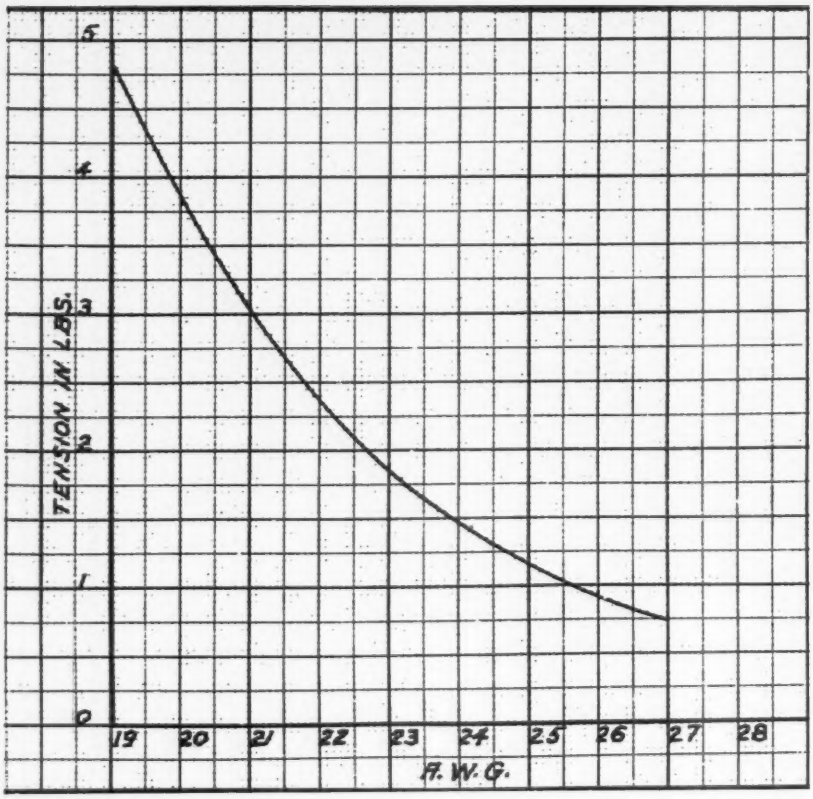


Fig. 6. Tension in Wire Due to Stress Set Up at Wire Speed of 12,000 F.P.M.

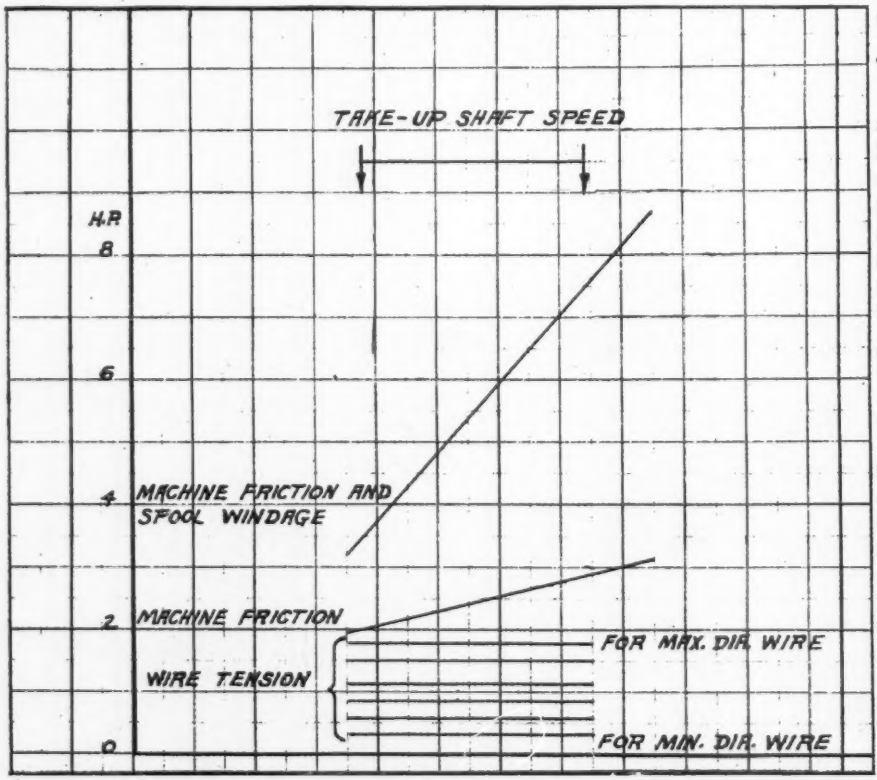


Fig. 7. Power Requirements for Torque Motor for Takeup of Wire Sizes No. 19 A.W.G. and Smaller to Secure Uniform Tension.

plying this by the area of each size of wire. The tension in the wire changes for each size of wire and remains practically constant throughout the entire reel; therefore, the horsepower required to take up wire on the reel remains constant from the core to the outside of the reels, the speed of the reel slowing down with the build up of wire on the reel. The lower curves on diagram Figure 7 show the horsepower requirements for taking up wire of different sizes.

✦ ✦ ✦

THE horsepower required to overcome bearing friction was calculated and is constant for all sizes of wire. The windage is governed by the design of the reel and the horsepower was determined by test for the minimum and maximum reel speeds. The data for these components is shown by the upper curves of diagram Figure 7.

✦ ✦ ✦

THE constant horsepower requirement for uniform tension when converted into torque shows that the torque increases as the wire on the reel builds up due to the lengthening of the radius arm.

✦ ✦ ✦

THE decreasing horsepower requirement to overcome windage and friction when converted into torque shows that the torque decreases with this build up of wire due to the slowing down of the reel when using a uniform speed of drawing. This decrease will be at a faster rate than the increase resulting from tension.

✦ ✦ ✦

THE calculated torques when plotted for the different sizes of wire within the scope of the machine show curves gradually diverging as the reel decreases in speed. To simplify the electrical control it was found these curves could be made parallel and still be within the allowable variation of wire tension and the required tolerances of the supplier of the electrical equipment. It was decided to select as the base curve that condition which would be most favorable to the making of the smallest size of wire and to use the average torque value from an empty to a full reel for the dif-

ferent tension requirements for the other curves. Therefore the composite curves as shown by diagram Figure 8 show the result of this compromise.

✦ ✦ ✦

THE curves showing the results of the test run of the takeup motors are shown by Figure 9, which demonstrates how closely the motor manufacturer met the requirements of Figure 8, which are superimposed for reference.

✦ ✦ ✦

THE minimum of slip between the wire and capstans has been incorporated into the design to secure the greatest economy of power. Each successive A.W.G. of smaller diameter increases 26% in length and a ratio of 23% between each capstan step has been found most economical. To further reduce power required, ratios of 25% have been used, but because of the uneven wear of diamonds this ratio is disturbed and excessive breaks occur at the location where the die has worn the fastest. With the ratio of 25% dies must be kept more evenly matched for reduction in area, and the expense of rematching dies, and the loss of production during the period of rematching, make this expense greater than the power charge with the 2% greater slip.

✦ ✦ ✦

INASMUCH as it is economical to maintain dies within definite ratios of reduction of area, by the same token it is also necessary to keep the diameter of the capstan steps within like proportion. A cutting chart is furnished and at such times as it is necessary to repair a capstan, the step which shows the greatest wear is repaired, the diameter determined, and by reference to the chart the diameters of the other steps are ascertained. This means that some steps are repaired although very little wear is seen, but it is advisable to do this to maintain the correct ratio.

✦ ✦ ✦

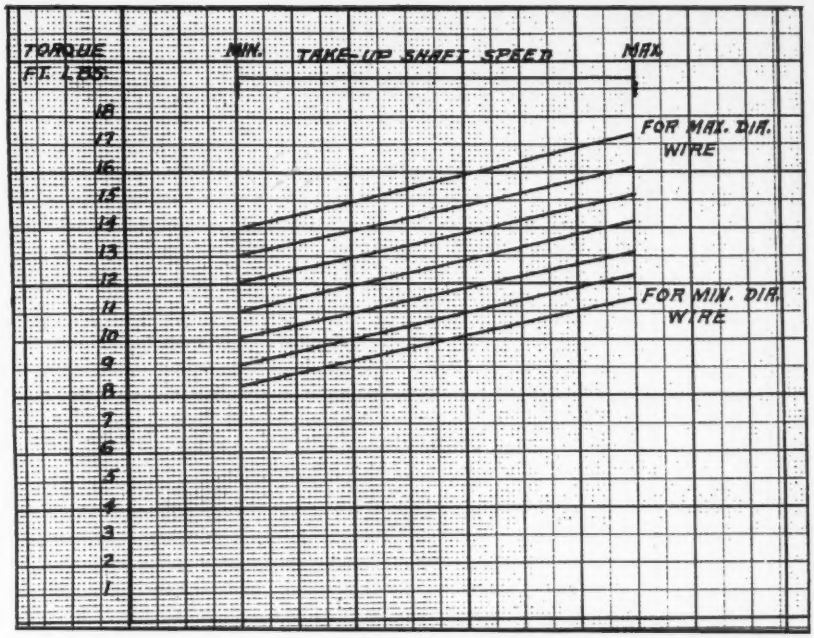


Fig. 8. Torque Requirements of Takeup Motor with Tension, Friction and Windage Combined for Wire Sizes No. 19 A.W.G. and Smaller.

✦ ✦ ✦ ✦ ✦ ✦

THE die pulls and power required to draw copper wire of any size are determined by referring to the chart, Figures 10 and 11, applicable for Tungsten Carbide and Diamond Dies respectively.

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IN using these charts the diameters of wire being drawn from and to are selected. The difference in areas represented by these diameters is determined, the curve is then chosen in the range of this difference, and by reading up from

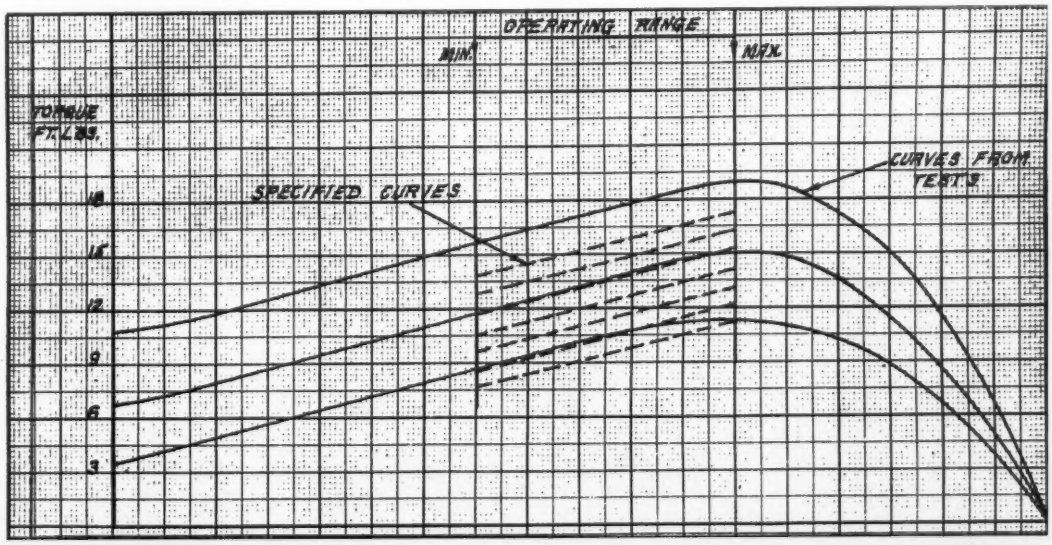

Fig. 9. Speed Torque Curves for Takeup Motor

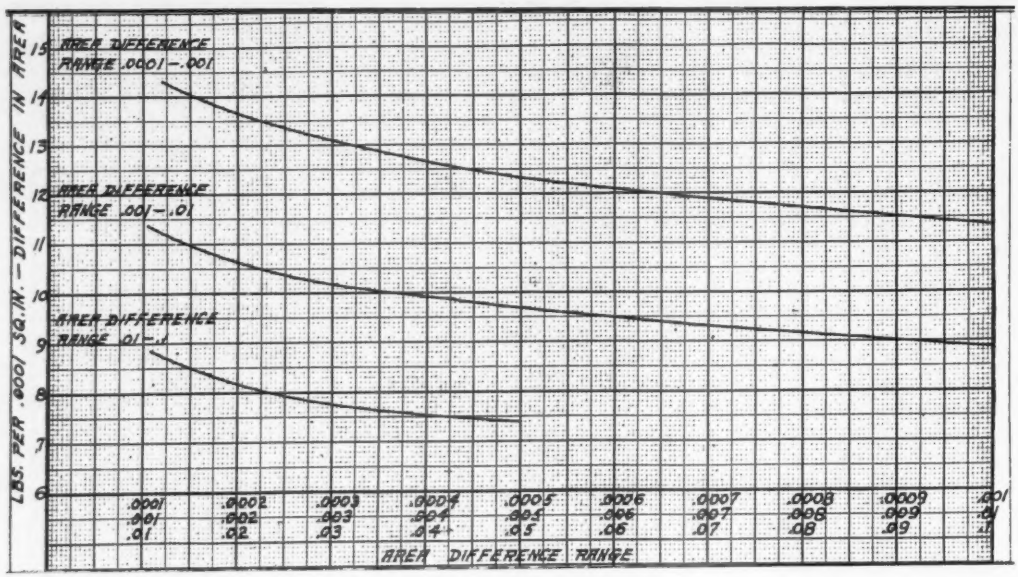
AREA DIFFERENCE RANGE .0001 – .001
AREA DIFFERENCE RANGE .001 – .01
AREA DIFFERENCE RANGE .01 – .1
LBS. PER .0001 SQ. IN. – DIFFERENCE IN AREA
AREA DIFFERENCE RANGE

Fig. 10. Constants for Determination of Die Pulls for Tungsten Carbide Dies Drawing Copper.

this difference to the proper range curve, the constant can be determined per .0001 sq. in. area reduction, which, when multiplied by the difference in area, will give the total pounds pull required to draw to the size selected.

Example:—Draw No. 9 A.W.G. to No. 10 A.W.G.
Areas—No. 9 = .01028. No. 10 = .00815. Difference = .00213.
Selecting Range Curve .001 to .01
Read up from .00213 to Range Curve = 10.6 lbs.
Multiply difference in area .00213 by unit pull of 10.6 lbs. = Pull through die = 226 lbs.

✦ ✦ ✦

CAPSTAN diameters are determined to secure minimum slip and from the die diameters selected, the pull through the dies is calculated. The horsepower for the main motor is determined from these die pulls and capstan speeds, to which is added machine and motor losses.

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AS the drawing machine is required to start up and accelerate under full load, a high torque squirrel cage induction motor was selected. This type of motor accelerates to full speed very rapidly, whereas the acceleration of the torque motor for the takeup is very much extended and would therefore result in very high slip between the wire and capstan. It was therefore necessary to introduce some auxiliary means to assist the torque motor to come up to speed. This has been effectively accomplished through the introduction of a magnetic clutch for coupling together the main and takeup motors during the starting period. This clutch is energized as soon as the starting button is operated and before the contactors for the main motor make contact. A time relay releases the

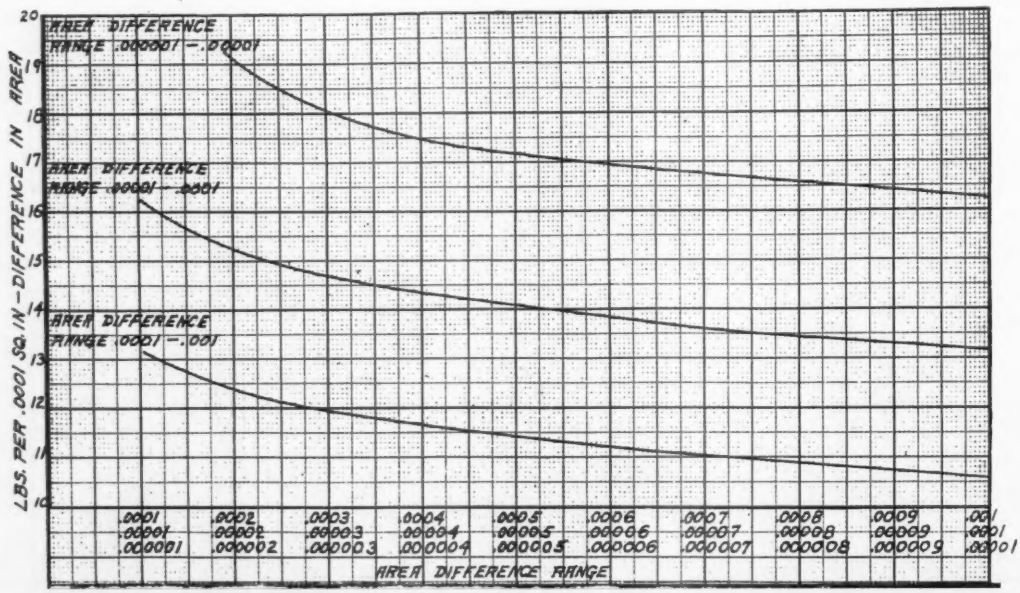
AREA DIFFERENCE RANGE .000001 – .00001
AREA DIFFERENCE RANGE .00001 – .0001
AREA DIFFERENCE RANGE .0001 – .001
LBS. PER .0001 SQ. IN. – DIFFERENCE IN AREA
AREA DIFFERENCE RANGE

Fig. 11. Constants for Determination of Die Pulls for Diamond Dies Drawing Copper.

magnetic clutch as soon as the main motor is up to speed. During this acceleration period on the No. 2 Machines a slip of 5% between wire and capstan occurs when the capstans are new, and no slip when the capstans are reduced to the minimum diameter. Curves showing the relative acceleration between main and takeup motors are shown on diagram, Figure 12, which also represents the improvement of acceleration by the tie-in. An electric time clock is connected into the motor circuit for stopping the machine when the 400 lb. reel is full, a time setting being made for each size of wire. On the No. 1 Machine the takeup is accelerated by the magnetic clutch to full reel speed of the 1000 lb. reel and the contact made by the time clock reenergizes the clutch so that the takeup will slow down in synchronism with the main motor.

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AN under current relay is also interposed in the motor circuit to stop the machine should a break occur while drawing.

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ANTI-FRICTION bearings have been introduced for all high speed revolving members, and the average life of the ball, or roller bearings, has in most cases exceeded the expectancy of the bearing manufacturers. Most of the bearing failures have been caused primarily by failure of the ball retainers.

✦ ✦ ✦

BECAUSE of the high speed and the possibility of oil leakage, there was some hesitancy in using oil for lubricating the bearings. Various grades of grease recommended for use with certain types of bearings proved inadequate. This condition was rectified by changing the design to permit of oil lubrication and the life of the bearings was increased 25 to 1.

✦ ✦ ✦

INTRODUCTION of oil lubrication introduced difficulties in securing effective sealing against oil leakage. It has been our experience that commercial seals are effective when used on shafts revolving at surface speeds below

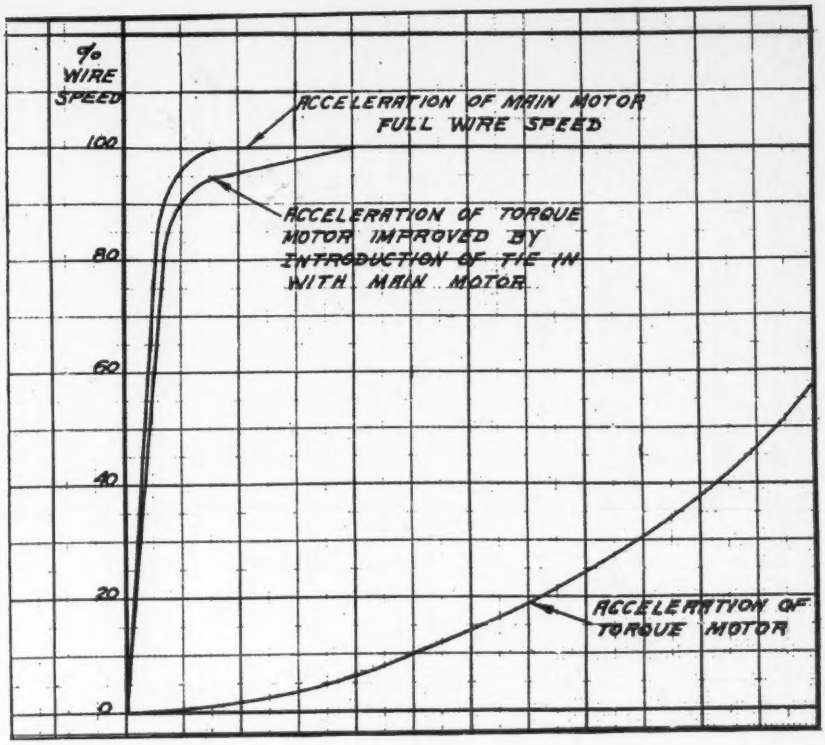

Fig. 12. Relative Acceleration Curves of Main and Takeup Motors. ✦ ✦ ✦

1200 f.p.m., but above this speed they were inadequate. For the capstan bearings the seals have to be effective in both directions to prevent the leakage of mineral oil from the bearings into the wire drawing compound, and also to prevent the wire drawing compound from mixing with the lubricating oil. This has been accomplished very effectively by the use of multiple slingers, the design of which is shown by Figure 13. The two front slingers throw off the compound which drains back into the compound system and the two rear slingers do the same with the oil. There is no

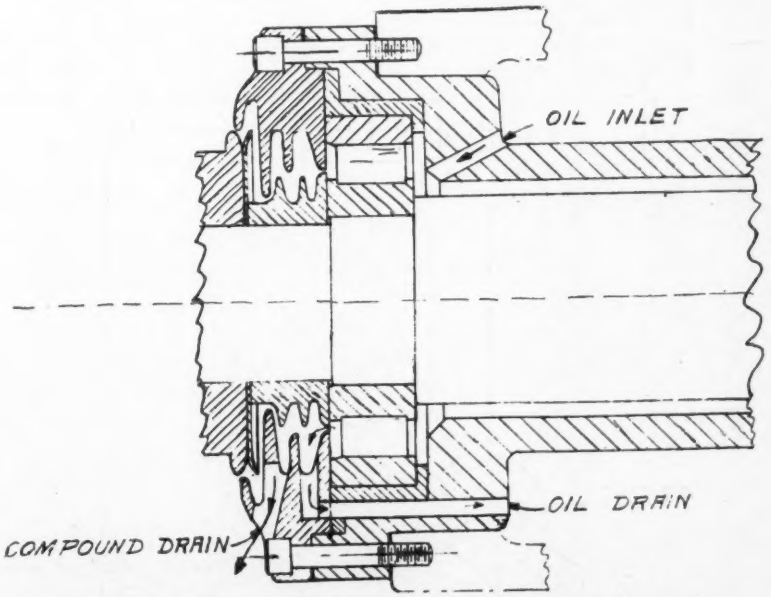

Fig. 13. Labyrinth Oil Seal. ✦ ✦ ✦ ✦ ✦ ✦ ✦

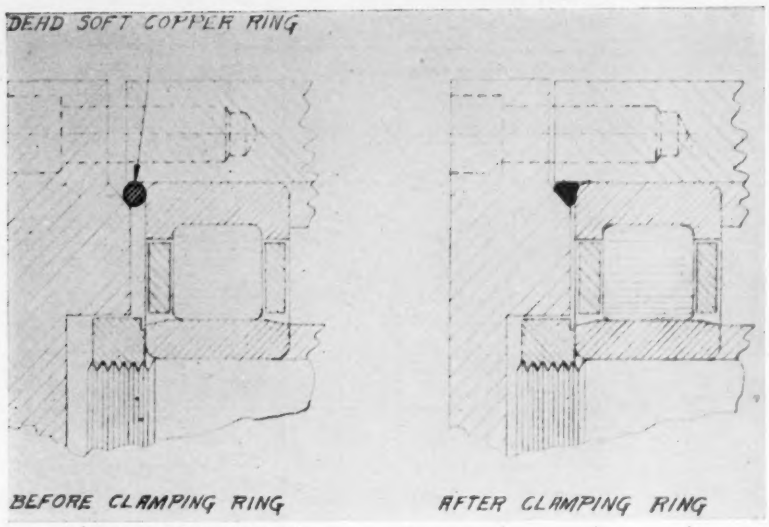

Fig. 14. Assembly of Oil Retaining Ring.

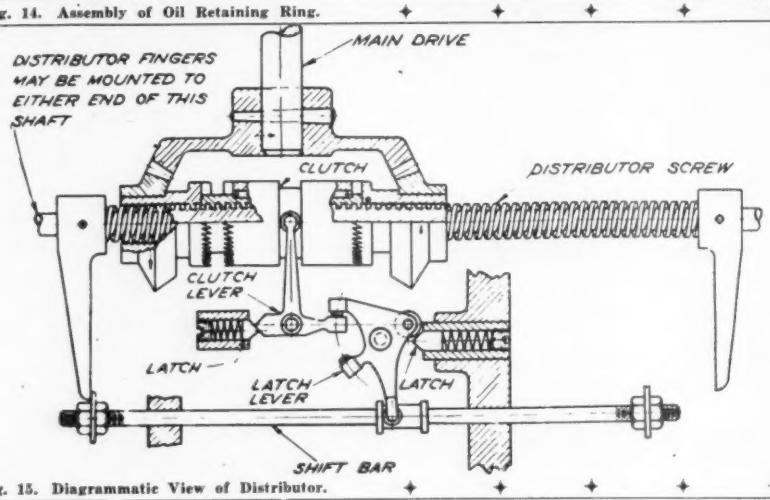

Fig. 15. Diagrammatic View of Distributor.

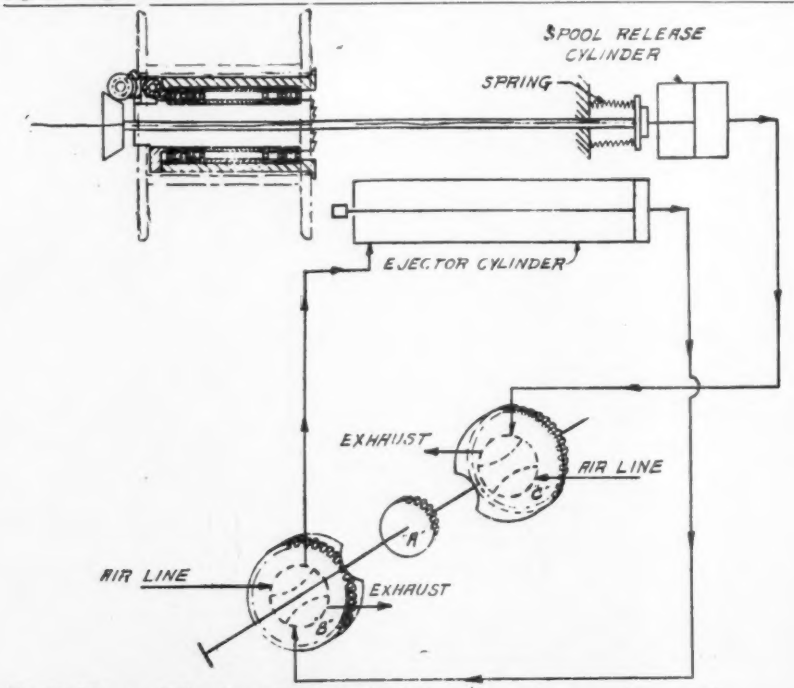

Fig. 16. Diagram of Clamping and Releasing Mechanism.

friction and corresponding wear between surfaces and only occasionally can small drops of compound be seen in the drain reservoir, which shows the effectiveness of this type of seal. As an extra precaution against contamination of oil with wire drawing compound, only a small amount of oil is permitted to flow to the capstan bearings, sufficient for adequate lubrication. This is drained to a reservoir and clarified before reuse.

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ANOTHER form of seal is shown by Figure 14. This is used at the takeup arbor where oil was driven through any commercial gasket material by centrifugal force. The oil was thrown out into the inside of the reels and caused discoloration during the annealing. This has been effectively sealed by making a ring of dead soft copper wire carefully joined. The end cap is bevelled to force the ring to the inside of the arbor and against the edge of the bearing, making a tight three-point contact. These rings are never used more than once.

✦ ✦ ✦

THE reels are provided with a magazine on the outside of the flange, in which magazine approximately 10 to 12 feet of the inside end of the wire is stored. At the subsequent operation this inside end is removed from the storage and joined to the outside end on the next reel, by which means continuous production with a minimum of scrap is secured.

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CONSIDERATION was given to a reel machined all over to get it in correct balance. However, it was realized that distortion would occur as a result of annealing the wire on the reel, and from the handling. Therefore it was decided to provide a very substantial construction of the takeup unit, with bearings of ample capacity to provide for any eccentric loading which might result from spools which had become irregular by use.

✦ ✦ ✦

WELDING facilities are provided to join the ends of wire on successive supply reels at the No. 2 Machines. A special hood

permits the transfer of supply from the emptied reel to the succeeding reels. The contour of this hood had to be developed to reduce the noise from the wire which is whipping around. The noise is further minimized by suitable ribbing of the hood, irregularly spaced to break up the frequency of vibration.

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A ROLLER conveyor is installed beneath the hood with a capacity of three 1000 lb. reels. These reels are upended with magazine down before welding the ends of two reels. After emptying the front reel, the three reels are pushed forward, the empty one being discharged at the front, leaving space for another full reel at the rear.

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A TURNTABLE is furnished at the supply end of the No. 1 Machine, which can be seen in Figure 3, with capacity for four coils sufficient for one full takeup reel. In operation, the bottom of the coil of rod is welded to the top of the succeeding coil, thus securing continuity of drawing. With the emptying of one position, the table is revolved through one quarter of a revolution, leaving the empty space for reloading the next coil which is then welded to the one ahead, the welding and loading being performed during the period of drawing.

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A SLOW speed stringing block and die support is provided for stringing the larger dies onto the wire and by depression of a foot switch the machine can be operated at slow speed for stringing the dies and wire into the machine.

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GOOD distribution of wire on the reels is essential to permit of easy removal of wire from the reel. The distributor designed for this machine is of the reversing screw type with a reversing clutch as shown by diagram Figure 15. At the speed with which wire is being delivered to the reel any pause at either end of the traverse would result in considerable build up of wire against the flanges. This type of distributor is practically instant reversing.

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THE average weight of wire on the takeup reel is well over 1000 lbs. for the No. 1 Machine and 300 lbs. for the No. 2 Machine.

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THE design provides for readily replaceable unit assemblies so that the machines are out of production for the minimum of time when any repairs are necessary.

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TO reduce the effect of vibration to a minimum, the main frame of the machine was constructed to keep as much weight as possible close to the floor and thus secure a low center of gravity. All parts revolving at high speed are given a dynamic balance. Welded construction was not as readily adaptable as castings, and would have been noisier.

SAFETY features have been incorporated into the design for the protection of the operators. Doors are provided so that the wire is fully enclosed during the drawing process and all revolving parts are amply protected. The clamping of the reel on the arbor is effected through spring pressure, air being used for releasing and ejecting the reel. An interlock is provided between the reel release and ejector as shown by Figure 16, Air Valve "C" effecting the reel release and air valve "B" controlling the ejector. Only one valve can be operated at a time, and they must be operated in proper sequence. The master control "A" is left in contact with the gear segment of Valve "C" until it is fully opened and the reel released. When "A" registers with the segmental opening, it can be withdrawn and moved over into mesh with segmental gear on Valve "B", the master Control "A" cannot be disengaged from "B" until the ejector plunger is back in correct position. Additional safety was introduced into the reels by making the flanges of an alloy casting, changing the factor of safety from 4-1 to 8-1.

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THE use of high speed machinery with large capacities of the takeup unit and introducing the minimum of slip between the wire and capstan has resulted in meeting the performances anticipated from this development.

SECTION II

Equipping And Operating A New Wire Mill

By J. E. Wiltrakis

A NEW copper wire drawing plant has been in successful operation for slightly more than a year at the Kearny, New Jersey Works of the Western Electric Company. Here, drawing speeds as high as 10,000 and 12,000 feet per minute are being used on the equipment described in the first section of this paper and approximately 2,000,000 pounds of 19, 22, 24, and 26 American Wire Gage bare annealed wire are delivered each month to the insulating machines for processing into lead covered telephone cables.

SUMMARY

This section covers the facilities provided at the Kearny Plant of the Western Electric Company for drawing wire at speeds up to 12,000 FPM, embodying the use of machines described in Section I and the associated equipment for die maintenance, drawing compound, annealing and material handling. The floor layout of the high speed drawing machines and the flow of material through the mill are described with examples of the refinements engineered into this installation.

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This section of the paper will describe

a. Die repairs and control

b. Drawing compound and equipment

c. Layout of principal Wire Mill equipment

d. Processes in the Wire Mill and flow of material

e. Operating Results

Alloy and Diamond Dies

PRIOR experience at the two other mills of this Company indicated the prime importance of good dies, and that in training die makers to produce tools of dependable quality, adequate controls must be provided. Alloy dies are used in the No. 1 drawing machines. The contours of these dies are made to definite angles now commonly used in the metal drawing industry.

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DIAMOND dies are used in the No. 2 drawing machines and it is here that definite die pull values, correct die contours, and a fine polish present definite problems.

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THE die pull test is performed on all dies as a means of grouping dies of a certain diameter and matching them into die sets, at the same time obtaining a check of the combined effect of die contour and polish. The die pull test consists of slowly and evenly winding 5 to 10 turns of wire about an arbor while reducing the wire one AWG size. The pull on the die holder is noted and checked against the following die pull requirements which have been set up as satisfactory values for our needs are shown in Table A.

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THE schematic of a diamond die cross section illustrates the general contour found to be most satisfactory for our high-speed copper wire drawing. (Fig. 17 Schematic Showing Cross Section of a Diamond Die Used for High - Speed Drawing). The approach blends smoothly into the reduction angle of the die. The length of the bearing is about 40% of the wire diameter. With the use of a contour projector, 100X enlargements of die impressions are periodically made as a control on the process of making the contour of the die.

Table A

Size of Diamond Die	Pounds Pull	Size of Diamond Die	Pounds Pull
15 B&S	75	21 B&S	21
16 "	60	22 "	17
17 "	49	23 "	13.5
18 "	40	24 "	11
19 "	32	25 "	9
20 "	25	26 "	7

✦ ✦ ✦

WELL graded diamond dust is needed for polishing. When made by flotation methods and properly controlled, the best results from a die processing and wire drawing standpoint are obtained. For final polishing, 6 micron diameter diamond dust is used. A binocular microscope which magnifies the surface condition 30X is used to determine the polish and the quality of the diamond itself.

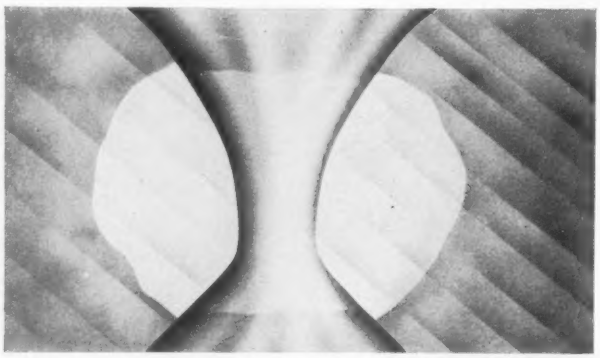

Fig. 17. Schematic showing cross section of diamond die used in high speed wire drawing.

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Fig. 18. Microscopic examination of diamond die polish by die maker.

BY maintaining dies according to a definite specification and matching them into sets, die troubles have been minimized on the Wire Mill floor. Records are kept of the characteristics and output of each die.

✦ ✦ ✦

THE minimum slip machines used at Kearny have been designed and are maintained with the view of overcoming some of the serious causes of short die life. These machine factors to which considerable attention was given were rough capstans, high slip, the whip of wire when entering dies and finally the lubrication and washing of the dies.

✦ ✦ ✦

THE increase in speeds up to 12,000 FPM does not appear to increase die wear. In other words, the same quantity and quality of wire is obtained per mil of die wear from high speeds as is obtained at low speeds. This is only true, however, if the drawing dies are made to a definite specification and the drawing machine factors affecting die life are relatively the same at the speeds being compared. (Fig. 18 Microscopic Examination of Diamond Die Polish by Die Maker).

✦ ✦ ✦

Drawing Compound and Equipment

A ONE story building is used for manufacturing wire. In the basement the drawing compound tanks, piping, heat exchangers, pumps, power services and controls are installed. The compound solution used

to lubricate and cool the capstans and dies in the drawing machines consists of a mixture of soap, fat and oil emulsified in a colloidal mill and mixed with water. This compound returns to a self-cleaning distributing launder in an enclosed steel tank. The launder consists of a pipe with slots evenly depositing the compound over the entire width of the tank. The copper sludge settles to the bottom and the lighter impurities rise to the surface to be held back by a skimmer plate. The clarified supernatant solution rises over a dam into the pump suction chamber to be pumped at the rate of 200 gallons per minute to each No. 1 machine and 100 gallons per minute to each No. 2 machine. The heat from the clean compound is

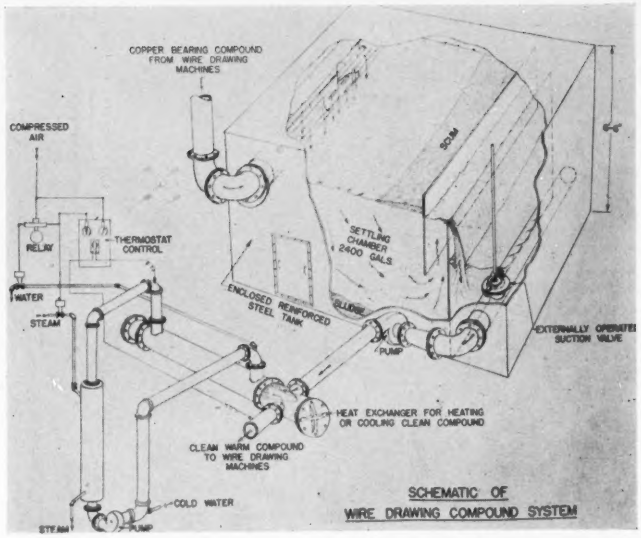

Fig. 19. Sectional sketch of compound system.

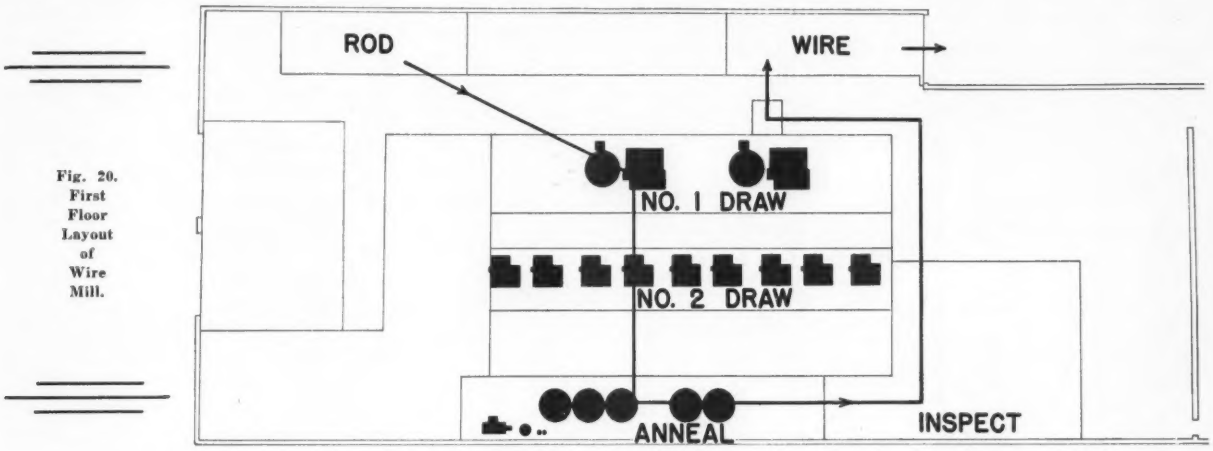

Fig. 20. First Floor Layout of Wire Mill.

removed in heat exchangers as the compound is delivered to the machines. The compound is maintained at approximately 130°F. by a closed recirculating water system thermostatically controlled. (Fig. 19 Sectional Sketch of Compound System for Wire Drawing).

✦ ✦ ✦

Layout of Principal Wire Mill Equipment

THE building used for wire drawing is ideally situated adjacent to the cable manufacturing unit and has facilities for water, rail and motor truck deliveries. The area is easily ventilated and has excellent illumination provided by mercury vapor lamps, close to a high ceiling yet providing an average of more than 20 foot candle illumination. Stroboscopic effect is practically eliminated by staggering the lamps over separate phases of the three-phase circuit.

Fig. 21. Auto truck delivering copper rod.

THE No. 1 machines are located adjacent to the copper rod receival area. The No. 2 drawing machines—nine of them in a row, are placed in the center of the building. Along the wall, five annealing bases for the electric bell type furnace are located. A bridge type crane handles all the material between the No. 2 machines, annealing and inspection. This layout of the equipment makes possible quick and easy transfer of material between operations, low inventories and multiple operation of machines by operators. It also makes possible the addition of increased capacity without rearrangement. Adequate space has been provided to facilitate maintenance. The entire distance from the receival of rod to the wire shipping area is 100 feet. One electric truck and the crane just mentioned suffice for all handling and transportation of materials in the building.

✦ ✦ ✦

ON either side of the main flow of material, space is provided for storage of rod, shop maintenance equipment and racks. (Fig. 20 First Floor Layout of Wire Mill).

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Processes in the Wire Mill and Flow of Material

COPPER rod is delivered on double prongs of an electric truck, approximately 4,000 pounds at a time, and is placed adjacent to each of the No. 1 drawing machines. (Fig. 21 Photo of Auto Truck Delivering Copper Rod). Here each 250-pound coil is placed on the floor of the eight foot diameter supply table. A maximum of four coils is maintained on the table at a time. The rod ends are electro-welded to form a continuous supply. As rod from one coil is converted to wire, the operator pushes a button and rotates the table 90° to locate the next coil. This process of supplying coils, welding rod ends and rotating the supply table is repeated while the machine continues to fill the 1000-pound reel with 14 gage (.064″) wire at 5000 FPM.

Fig. 22. Upending device for 1000-pound supply reel at back of No. 2 machine. ✦ ✦

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WHEN the machine automatically stops, the operator opens the spooler compartment and actuates an air operated mechanism which releases and pushes the two foot diameter 1000-pound reel off the takeup arbor. An empty reel is placed on the arbor and locked. The guard is closed and the push button starts the machine with no additional attention on the part of the operator, who returns to the welding operation after placing the filled reel in the storage area.

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THE 1000-pound reel must be upended before it can be placed under the supply compartment of the No. 2 machine. The upending device consists of two floor castings, a pneumatic hoist and cables. The operator first rolls the large reel on the first floor casting and then actuates the pneumatic hoist. The cables hinge upward two castings like covers of a partly closed book, forming 45° angles with the floor. At this position the weight of the reel settles onto the second casting. The operator releases the air and the reel is gently lowered upon floor rollers. The axis of the reel is now vertical. One end of the copper wire is electro-welded to the end of one of the two reels in the supply compartment. As the machine empties the first reel, the operator pushes the second and third reels into the supply position within a compartment. A continuous supply is thereby provided with safety and ease of handling. (Fig. 22 Photo of 1000-Pound Supply Reel at Back of No. 2 Machine in Upending Device).

✦ ✦ ✦

THE duties of the No. 2 machine operator principally consist of furnishing several machines with supply wire, removing filled reels of drawn cable wire, gaging wire, starting the machines and periodically adjusting for tension. Breaks are infrequent as evidenced by the fact that the average weight of reels shipped during the first six

Fig. 23. Line-up of No. 2 machines. ✦ ✦ ✦ ✦ ✦ ✦

months of 1940 was over 340 pounds. When these breaks occur or when a change is made in the die sets, this operator also strings up the machine. (Fig. 23 Photo of Line-up of No. 2 Machines).

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ON these machines wire is drawn at 10,000 FPM. The importance of the various mechanical and electrical details mentioned in the first section of this paper can therefore be visualized. One of the No. 2 machines has, for the past ten months, operated with certain refinements at the finishing speed of 12,000 feet. The data being collected so far is favorable and it is expected that this study will justify the conversion of additional machines to the higher speed.

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AFTER the takeup reel is released and pushed off the arbor by the air operated mechanism, it is rolled to the area below the bridge crane and upended by hand.

✦ ✦ ✦

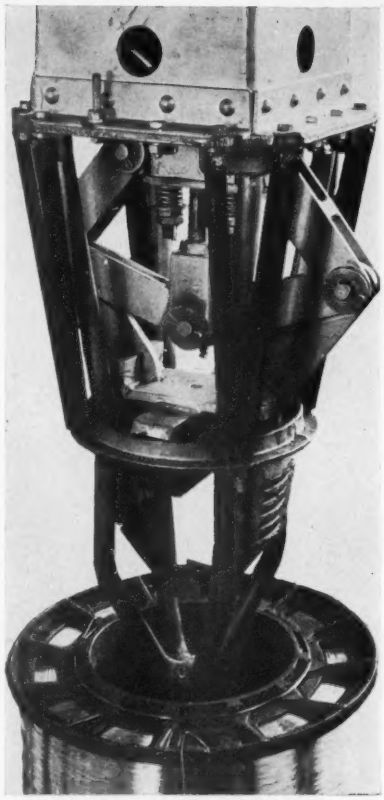

Fig. 24. Solenoid operated chuck grapple being located to lift reel of wire. ✦ ✦

Multi Purpose Crane

THE movements of the bridge crane and grapples are controlled from the crane cab by the operator. A six-ton grapple handles the baskets of wire, the electric furnace bell and the furnace details which will be mentioned later. The crane is also equipped with an auxiliary hoist to lift the wire reels into the annealing basket. To this hoist, a locating device has been attached together with solenoid operated, internal expanding jaws which engage in the wire reel core. (Fig. 24 Solenoid Operated Chuck Grapple being located to lift reel of wire). With safety and facility of operation, twenty-eight reels, a total of 10,000 pounds of wire, are loaded into a 56″ diameter light weight perforated steel basket. (Fig. 25 Photo of Six-Ton Grapple Placing Basket of Wire on Annealing Base).

✦ ✦ ✦

Batch Type Electric Annealing Furnace

THE operation of electric batch type annealing furnaces and the use of reducing gas atmospheres, with an average composi-

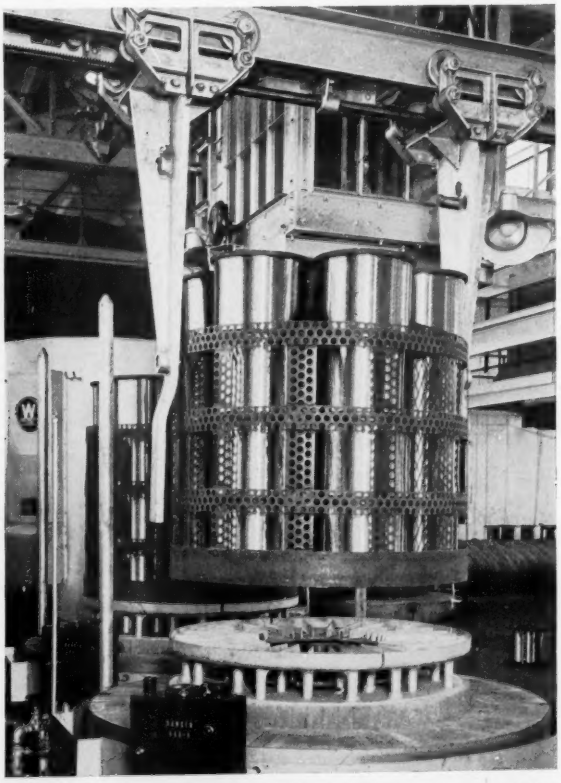

Fig. 25. Six-ton crane grapple placing basket of wire on annealing base. ✦ ✦ ✦ ✦ ✦ ✦

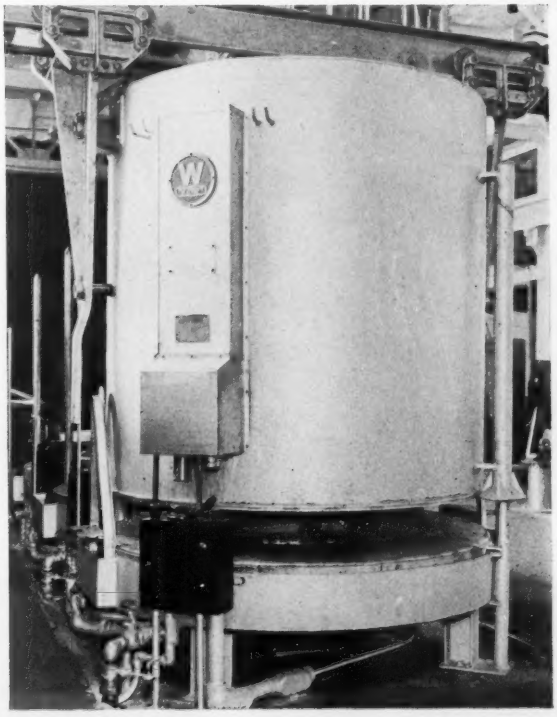

Fig. 26. Electric furnace bell, with automatic plugging equipment, being placed over covered charge. ✦ ✦ ✦

✓ Check

☑ **CUT OUT THE "CUT OUTS"**
Morgan Wire Drawing Machines can be depended upon to maintain the quality required.

☑ **INCREASE THE "PER HOUR" OUTPUT**
Morgan Wire Drawing Machines are built for continuous high production.

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Morgan Wire Drawing Machines have automatic safety features.

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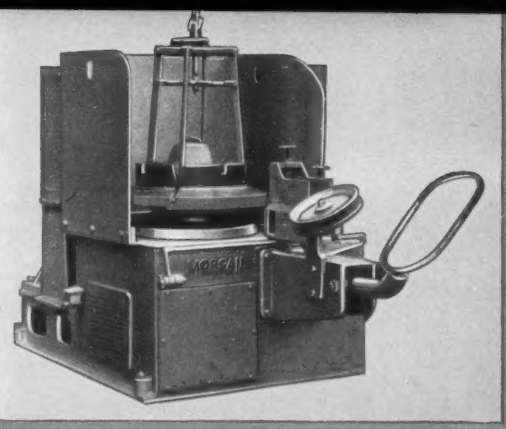
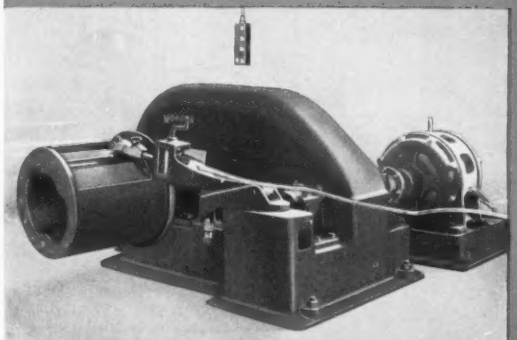
Continuous Wire Drawing Machines; Take-up Frames; Horizontal Bull Blocks; Vertical Spindle Bull Blocks; Reels; Pointers; Wire Mill Accessories.



Morgan Wire Block, a compact vertical spindle machine for single draft, or two drafts on double deck blocks.



Morgan No. 105 Horizontal Bull Block for coarser sizes, affording highest production and economy through quicker stripping of coils.

Left: Morgan - Connor Continuous Wire Drawing Machine, Type B-W. Six air-cooled high blocks. Will draw No. 4 to finished rope wire .090" at 1,000 FPM.

WING MACHINERY

• • WORCESTER, MASSACHUSETTS

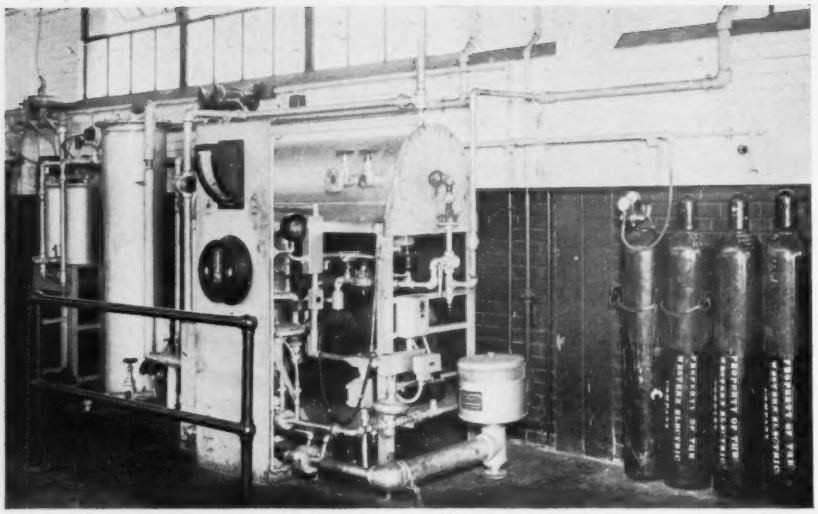


Fig. 27. Gas generator and N_2 tanks used as stand-by equipment.

Fig. 28. Inspection and shipping area.

tion of about 1-½% CO, 2% H_2 and 14.5% CO_2, produced by combusting city gas are generally known to the wire industry. Certain provisions in the Kearny installation may be of interest.

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DETAILS of the annealing baskets and bases, the steel alloy retorts used to cover and water-seal the charges, and the electric furnace moved from base to base have been designed so that the arms of the six-ton crane grapple can engage, handle and move these items.

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THE electrical connections to the furnace bell are made automatically. This design consists of control and power plugs located on the exterior of the furnace and a floor stand with positions for electrical receptacles. Two pins align these units, one of which opens the receptacle covers as the furnace is lowered over the retort. (Fig. 26 Photo of Electric Furnace Bell, with Automatic Plugging Equipment, Being Placed Over Covered Charge).

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FEATURES such as these make it possible to perform all the furnace and crane operations, to deliver wire to the inspection area, to load skids for shipment of wire with a minimum of effort on the part of the operator. He attends these operations from a crane cab and as required, operates and adjusts the gas, water and drain valves from floor positions.

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IN the event of power, gas or generating equipment failure, automatic indicating equipment summons the operator who then connects a 8% H_2-92% N_2 mixture into the annealing gas lines. This has provided inexpensive stand-by equipment and constant production of bright annealed copper wire. (Fig. 27 Photo of Gas Generator and Nitrogen Tanks Stand-by Equipment).

✦ ✦ ✦

Capacity and Results

AT the present time this mill is set up to produce on a five-day week, three-shift day basis, approximately 22,000,000 pounds annually. The equipment of the type described, including space for rod and wire storage, occupies an area of approximately 14,000 square feet. Training time was not excessive for the average operator — efficiencies of 80% to 90% being attained in a few months. Rotation of operators to the next shift every two weeks has worked out satisfactorily.

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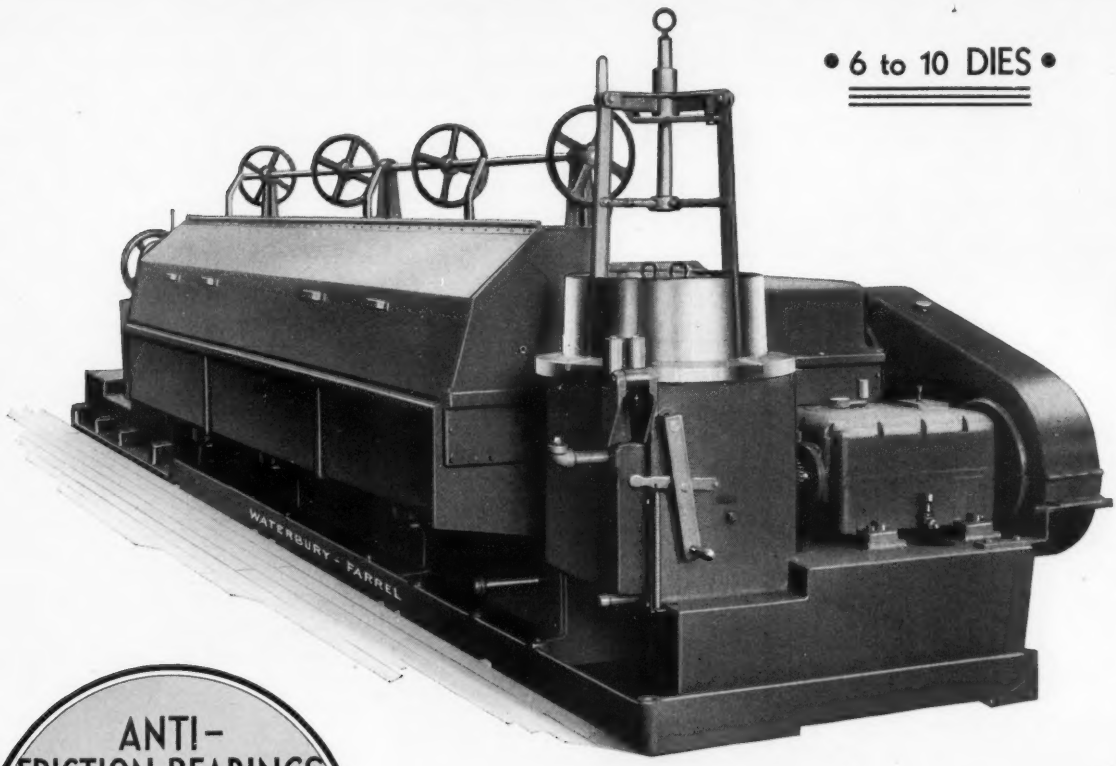
PERIODIC checks and maintenance of electrical circuits and apparatus, with adjustments of mechanical assemblies before major repairs arise, has kept repair costs low. Additional training and experience should further reduce maintenance and repair time. The use of diamond dies in diameters up to and including 15 AWG has been found economical for high-speed machines. Cracked dies are negligible when properly mounted clear stones are used. The results based on a year of operation have proven in the anticipated econom-

(*Please turn to Page 636*)

WATERBURY-FARREL

NO. 1 TANDEM WIRE DRAWING MACHINE - FOR BRASS OR COPPER

• 6 to 10 DIES •



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FORCED FEED LUBRICATION

SPIRAL BEVEL GEARING

Change gearing provides four finishing speeds with a single speed AC main motor.

Block driven through a clutch which may be disengaged to permit rotation by hand.

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WATERBURY, CONNECTICUT U.S.A.

CLEVELAND CHICAGO NEWARK, N. J.

What Does Good Laboratory Practice Do To Help Production In The Steel Plant?

By George P. Lenz, Jr.,
Metallurgical Department,
Union Drawn Steel Division, Republic Steel Corporation,
Massillon, Ohio.

In many respects the laboratory is a non-productive department whose existence is justified only to the extent that it is able to help production. In this connection it possesses three definite functions: material control, production control, and new developments. By these means the laboratory can assure that the correct product is produced and also can materially aid reduction of cost.

PRODUCTION problems in the past have been met and solved more often than not by the "try again method", which in most cases has proved rather costly. With the increasing number of types of materials and the more rigid specifications, it has become increasingly necessary to develop good laboratory practice to help production, and the present production laboratories of fabricating plants, such as wire mills and cold finishing plants, have grown as much from that necessity as from any particular foresight.

✦ ✦ ✦

THE laboratory has three definite functions with which to aid production . . . Material control, production control, and new developments. By these means the laboratory can assure that the correct product is produced and also can materially aid reduction of cost.

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MATERIAL control can be classified in two groups; incoming or raw materials, and outgoing or finished products. Of primary importance in every producing plant is the assurance that the materials applied on an order are of the correct specifications. Even though utmost care is exercised in marking or tagging rough stock, there are many instances where the identification is lost. There is also the possibility that the supplier of the rough stock has made an error in identification. It is evident that the most costly mistake would be to produce material which does not conform to customers' chemical, microstructure, or physical specification, ship it to the customer, and then have it rejected and returned. This can be avoided by efficient laboratory control over incoming products.

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SECURING a representative sample, and the method of sampling are both very important. Precaution should be taken to make sure that samples from various parts of a heat of steel, rather than from one or two ingots, are secured. This problem is quite simple when the rough stock is received in bars. Each lift will represent the product of at least one and usually not more than two ingots. Samples from the various lifts should be taken, thus obtaining a good distribution throughout the heat.

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Graduated from Carnegie Institute of Technology in June, 1937, with a B.S. in Metallurgy. Began work with the Union Drawn Steel Division of the Republic Steel Corporation, July 1937, and is now employed there as a Research Metallurgist.

✦ ✦ ✦

COIL sampling is somewhat more difficult. Unless specified on a hot mill order, there may be no way of identifying the various parts of a heat of steel. If such is the case, a large number of samples should be obtained in an effort to get a good representation of the heat. There are some hot mills whose practice it is to tie a loose wire through the coils produced from one ingot. This makes the sampling of these lots similar to that of bars in that samples from each group of coils can be obtained.

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AS to the number of samples to be taken for chemistry on any given amount of material, this depends on the elements to be checked. For Carbon, Manganese, and Sulphur, several check analyses are needed because of the possibility of segregation. For Silicon, Phosphorous, and alloying elements, one check on a heat would be sufficient. Samples for analysis may be sawed, cracked, or burnt off. Samples for micro-examination and physical properties should be taken at random, the number being wholly dependent on the amount of steel and the type

of material. The samples should be removed by cold sawing. Burning off this type of sample may cause a change in the microstructure and physical properties and therefore a false interpretation of properties would be obtained.

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IN an effort to help production, sampling of incoming products should be done as soon as the steel is available, and testing of steel should be completed as accurately and as fast as possible. If handled in this manner there will be no delay in the production schedule. Laboratory procedure should be arranged so that all determinations are operating simultaneously rather than one following the other. In most cases chemical checking is the lengthiest procedure. This may be reduced by checking only sufficient elements to identify the steel. Carbon, Manganese, and Sulphur, along with spark and spot testing, are usually sufficient to verify a heat of steel. There is available a Combustion Carbon and a Combustion Sulphur determinator which can save considerable time on analysis checking. With this equipment it is possible to report a carbon and a sulphur check within ten minutes after the sample has been cut. The Carbon determinator applies the principal of short time high temperature combustion, finally measuring indirectly the volume of CO_2 evolved. The Sulphur determinator uses the same type of combustion, with the evolution of SO_2 and conversion to SO_3 in the solution to be titrated.

VERIFICATION of the finished product is of much importance to production. Again, regardless of how much precaution is taken in handling the steel through production, there are times when the identification is lost. Laboratory methods have been applied to mill inspection with much success.

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SPOT and spark testing are efficient means of verifying the grade of steel of finished products. Spot testing is generally used for the identification or separation of nickel bearing alloy steels from plain carbon steels and alloy steels that do not contain nickel. It is also possible to separate the SAE 3100 series containing 1.00/1.50% nickel from the SAE 2300 series containing 3.25/3.75% nickel. In using the spot test it is necessary to cleanse a small area of steel free from scale or any other foreign matter, preferably by grinding or filing. Then put two or three drops of HNO_3 (1:1) on the cleansed area. When the action ceases, absorb with a piece of blotting paper and immediately apply on the wet spot on the blotting paper two or three drops of a solution of six grams dimethyl glyoxime, 60 grams ammonium acetate, 270 c. c. of glacial acetic acid; 180 c.c. NH_4OH. If nickel is present, the spot will turn red . . . if absent the spot will turn brown. In separating the SAE 3100 series from the SAE 2300 series, the intensity of the color is the determinating factor. The SAE 2300 series will give a bright red indication, whereas the SAE 3100 series will give a pink coloration.

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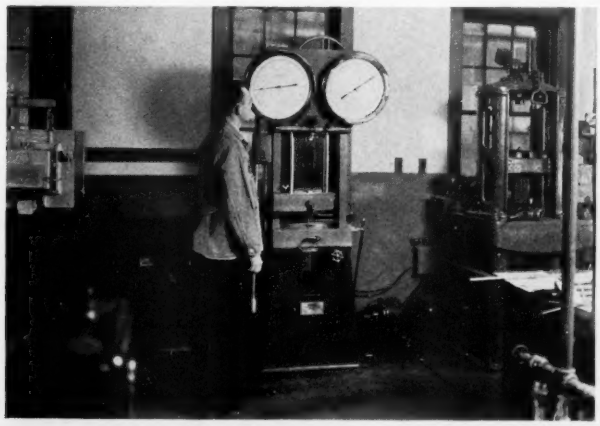
SPARK testing is an inexpensive and fast method of verifying a heat of steel or for separating mixed steels. The principle of spark testing is the tearing of small particles of metal from the sample by means of a high speed abrasive wheel causing the temperature of the particles to be raised to incandescence. Observation of the light streak and the final bursting of the incandescent particles affords a means of determining various elements present and their comparative amounts. The most useful interpretation of the spark test is in connection with carbon content of the sample. The intensity of the spark burst increases in proportion to the amount of carbon present. Along with being the most useful, the carbon spark is the easiest to identify as well as to learn to interpret. Within a few weeks an operator with sufficient opportunity to practice will be able to differentiate .15% carbon under .50% carbon and approximately .20% carbon over .50% carbon. The presence of other elements, such as nickel, molybdenum, silicon, and tungsten, can be determined by their effect on the carrier line and the spark burst. Determinations of this type take considerable practice and experience.

✦ ✦ ✦

THE training of men for spark testing should be done with extreme care and patience as they can become very valuable men.



Hydraulic Tensile Machine in Operation.

Combustion Carbon and Combustion Sulphur Equipment.

After selecting men with good sight, they should be supplied with sufficient literature on the theory of spark testing. With the understanding of the principles, the men should then work with samples of known quantities until they themselves feel certain of their skill. Standard samples should be kept on hand at all times for comparative purposes.

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HARDNESS checking, in a good many cases, will indicate if there is any mixed steel. Magnetic Analysis equipment has become a very efficient tool in mill inspection for separating mixed grades of steel.

✦ ✦ ✦

THE locating of small laboratories throughout the various departments of the mill has helped considerably in reducing delays in testing, consequently aiding in the lowering of production costs. A good example of the manner in which a small mill laboratory operates to prevent excess cost can be illustrated in the following way:

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AS soon as the first coil of an order comes off the drawing block, the mill laboratory man gets his sample and completes the testing before the next coil is ready. If he finds something that is not correct as to specification he can immediately hold up the production. Without a mill laboratory functioning in this manner, it is possible that the entire order would be completed before samples could be cut and sent to the regular laboratory. This type of delay would prove costly if the product did not meet the required specifications.

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WE can conclude from the above statement that the whole purpose of laboratory control of incoming and finished products is to prevent the mill from encountering excessive production cost due to the processing and shipping of incorrect steel.

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THE second function of the laboratory, in its help to production, is the control of production operations involving laboratory supervision. These operations include annealing, pickling, drafting and methods of final inspection.

✦ ✦ ✦

ANNEALING of steel is a very critical operation because small variations in temperatures and cooling rates can vary the structure, and likewise the hardness, considerably. Again, it is the duty of the laboratory to prevent the mill from processing steel which will not meet the customer's specification. Micrographic analysis of all annealed structures is essential in laboratory control. First, to assure that the steel has been annealed correctly to meet specifications, and second, for guidance in further processing.

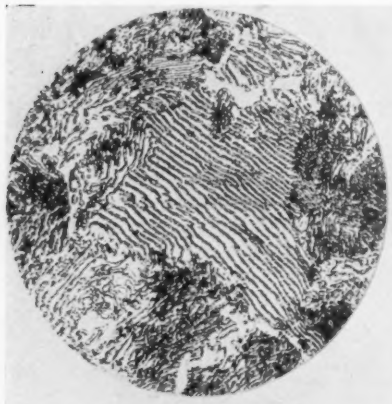

Figure 1

Figure 2

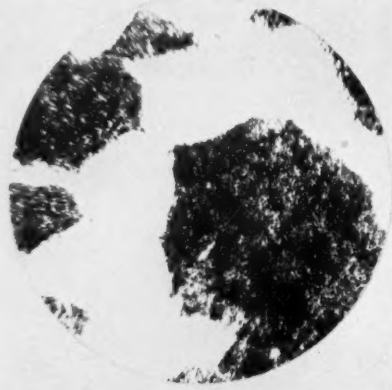

Figure 3

Figure 4

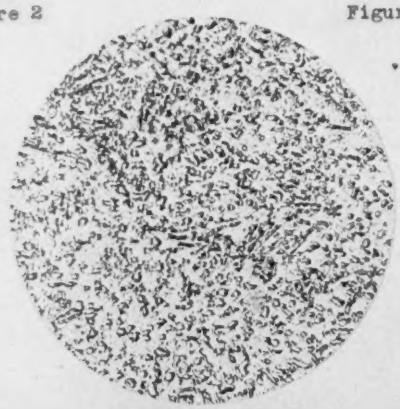

Figure 5

IT is quite possible to have steels of varying structure with approximately the same hardness; one structure suitable for machining and the other not so. In figures 1, 2, 3, 4, and 5, are illustrated the effects of the cooling rate on the structure of steel annealed for machinability. Fig. 1 . . . Cooled 15/18° per hour through the critical range . . . Structure—lamellar pearlite in a matrix of ferrite . . . ideal machining structure. Fig. 2 . . . Cooled slightly faster than steel in Fig. 1. Structure—lamellar pearlite and sorbitic pearlite in a matrix of ferrite . . . good machining structure. Fig. 3 . . . cooled too fast through the critical range. Structure—sorbitic pearlite in a matrix of ferrite . . . poor machining structure. Fig. 4 . . . Steel cooled faster than Fig. 3.—Ferrite not out of solution. Structure—fine grain sorbitic . . . unsatisfactory machining structure. Fig. 5 . . . Cooled too slow, causing spheroidization of the pearlite . . . very poor machining structure.

✦ ✦ ✦

IF the problem were to produce a steel for cold upsetting, the spheroidized pearlite as shown in Fig. 5 would be desired. The hardness of the structures in figures 1, 2, 3, and 4, would not vary sufficiently to be any definite criterion of machinability. The hardness of the structure in Fig. 5 would be definitely lower than the others.

✦ ✦ ✦

MICROGRAPHIC analysis is used to control the production operation of grinding to remove decarburization. With the knowledge of how much decarburization there is on the steel, the mill will know how much draft is permissable to leave enough stock for grinding.

✦ ✦ ✦

LABORATORY control of pickling is the development of pickling solutions, a suitable means for determining acid concentrations for periodic checking, and experimentation of the most economical ratio of time to pickle and acid concentration before it is necessary to make a new solution. Once this has been set up it is only necessary for the laboratory to maintain its operation by periodic checking.

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IN the cold drawing of steel, the amount of reduction is very important in that it controls the physical properties and finish of the steel. Cold drawing to meet definite hardness requirements is the most frequent specification. It is necessary for the laboratory to have data on the effects of varying drafts on all grades of steels available from past records and experimentation. For cold heading applications of cold drawn steel it is necessary to finish the steel with the minimum amount of draft that will produce a satisfactory surface. The amount of draft to meet a definite hardness, maximum or minimum, is controlled by the grade of steel and the hot rolled or annealed hardness. With a steel that work hardens very readily, and has to meet a low maximum hardness, it is often necessary for the laboratory to set up double drawing and annealing. There are cases where an order has been set up for annealing and cold drawing and because of some previous operation, the steel will not meet the hardness specification. An example would be steel that has been hot rolled oversize. When the first coil is drawn, the laboratory mill inspector immediately finds the steel too hard, holds up production, and submits the order to the laboratory for investigation and further processing. Even though the cost of production may increase some on this item, the amount saved by finding the trouble immediately, thus preventing the production of scrap, will over-balance it.

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COLD drawing to definite physical properties is primarily set up from past experience. When a new problem arises it is the procedure of the laboratory to have a sample of the steel drawn with the amount of draft approximated as necessary and then test. The procedure is also followed for annealing after cold drawing to meet definite properties. All of the laboratory control of production operations is to assure the mill that the correct steel is produced, thus avoiding claims and scrap, again preventing excess cost.

✦ ✦ ✦

PROBABLY the most important aid the laboratory can give production is development and experimentation on improvement of present production practices and product. Problems confronting the mill should be submitted for laboratory investigation. Development work can be done in the laboratory at much less cost than on a production basis. First mistakes in development work are much less costly when work is done on a laboratory scale.

✦ ✦ ✦

THE volume of laboratory work has been increasing steadily in the past few years. Formerly the ladle analysis and check analysis on one or two elements were sufficient to qualify a steel for an application. Today it is often necessary to check chemical analyses for an application as well as the as-rolled-grain size. McQuaid-Ehn grain size, hardenability, etch test, etc. In view of the much wider knowledge of the characteristics of steel as applicable to practical uses, it naturally fol-

Metallographic Microscope.

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lows that an increased amount of investigation is necessary. With our knowledge of steel ever increasing, it is evident that we will be performing tests in the future that are as yet unknown.

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GREATER demands are now being made on the uniformity of steels because of the tendency toward use of lower cost steels where higher cost steels were previously used. Current high speed production methods and close delivery requirements have necessitated faster determinations in the laboratory. With the demands of increased volume of testing and less time allowed, it has become necessary for the laboratory to operate on a production basis.

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SAMPLES for metallographic inspection, formerly cut by hand, are now cut on a high speed, wet, abrasive wheel, saving considerable time. The mounting of these specimens has been facilitated by the development of low melting alloys, plastics, and transoptic materials. These types of mounting are especially favorable for samples of irregular shapes. Newly developed, electrically-heated, hydraulic presses have superseded the old melting pot and ladle technique of mounting samples. For routine samples of regular sections, such as small rounds, squares, and hexagons, a very satisfactory method of high speed and efficiency is the use of metal rings with a set screw. These are easily made from a one inch inside diameter pipe, cut one inch long, and tapped for a set screw. Using this method, it is possible to mount, grind, and polish several samples at one time. The rings can be used repeatedly.

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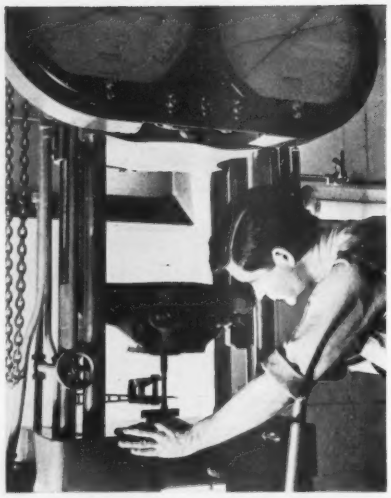
FOR laboratory heat-treating it is advisable to have at least two furnaces, one furnace operating in the range of the quenching temperatures, and the other at low temperatures for draws.



Hydraulic Testing Machine Showing Autographic Recording Strain Gauge. ✦

With only one furnace much time is lost in heating and cooling to accommodate the high and low temperatures.

✦ ✦ ✦

PHYSICAL testing has been improved by the development of hydraulic-testing machines with dial indicators and autographic recording devices. The hydraulic machines are much faster in testing, necessitating loading and unloading successively, such as in proof stress determinations. The ease of manipulation of the hydraulic machines and the accuracy of results have been a great step forward in laboratory determinations.

✦ ✦ ✦

THE most frequently used hardness testing machines are the Brinell and the Rockwell. Both of these machines have been improved to speed up determinations. Direct reading, power-loading Brinell machines for production use are replacing the old hand type, using a Brinell microscope. Superficial Rockwell Hardness Testers have been developed for use on thin sections of all hardness ranges.

✦ ✦ ✦

THERE are various other types of hardness testing machines which are adapted for a particular type of testing. The Monotron is especially adaptable for hardness determinations at various depths. The Vickers hardness tester is used on materials of very high hardness. The Scleroscope hardness tester is a non-destructive tester and is well adapted for testing finished materials. Other types of testing machines, such as the Microcharacter, and the Hubert Pendulum are not adapted to production requirements.

✦ ✦ ✦

AN efficient laboratory should have equipment suitable for handling all necessary work in the proper manner. Makeshift equipment often causes much delay and unsatisfactory results.

✦ ✦ ✦

GOOD records of all laboratory work are of inestimable aid in guiding production on new business. As an example, much time and money are spent to develop annealing and drafting practice on a special item, and the item is produced and shipped. Some time later another customer may enter an order for the same type of material. With laboratory records available to show the past experience on the type of product, it is possible to eliminate the added expense of redevelopment.

✦ ✦ ✦

FLEXIBILITY of the laboratory to facilitate production requirements is a great help to production. Laboratory procedure and equipment should be such that routine work can be com-

High and Low Temperature Furnaces and Quenching Tanks. ✦

pleted in a minimum amount of time. Laboratory operations should be planned and controlled so that any emergency calling for an increased amount of work of any particular type can be handled without hindering the regular routine work.

✦ ✦ ✦

LABORATORY men should be versed in all phases of laboratory work and also have a thorough knowledge of mill operations. They should be chosen for their ability to work rapidly and accurately. Each man should understand the reason for the tests that are performed so that he realizes the responsibilities involved.

✦ ✦ ✦

SUPERVISION of laboratory work should be insignificant in that each man should be capable of doing the type of work required for any order, whether it be physical testing, chemical testing, or hardenability determinations. Each man should have a general knowledge of metallographic examination so that he can assist in this type of work when necessary. The importance of having versatile men in the laboratory is demonstrated when a situation arises necessitating metallographic examination of a large number of samples. To complete this type of work as quickly as possible it is necessary to have a steady flow of samples prepared for micro-examination. The preparation of a sample for microstructure involves several operations: cutting of sample, identifying the sample, and mounting and polishing. Of these, the polishing operation takes the longest time. To maintain a steady flow of samples to the microscope requires several men on polishing alone. It becomes exceedingly important, therefore, for every man in the laboratory to be able to perform such necessary operations. Whenever the mill has to advance production on an order, the laboratory should immediately be able to do the same.

✦ ✦ ✦

IN many respects the laboratory is a non-productive department whose existence is justified only to the extent that it is able to help production. Certainly a prime purpose of the laboratory is to aid in producing the best product, the most advantageous way, with the least cost.

✦ ✦ ✦

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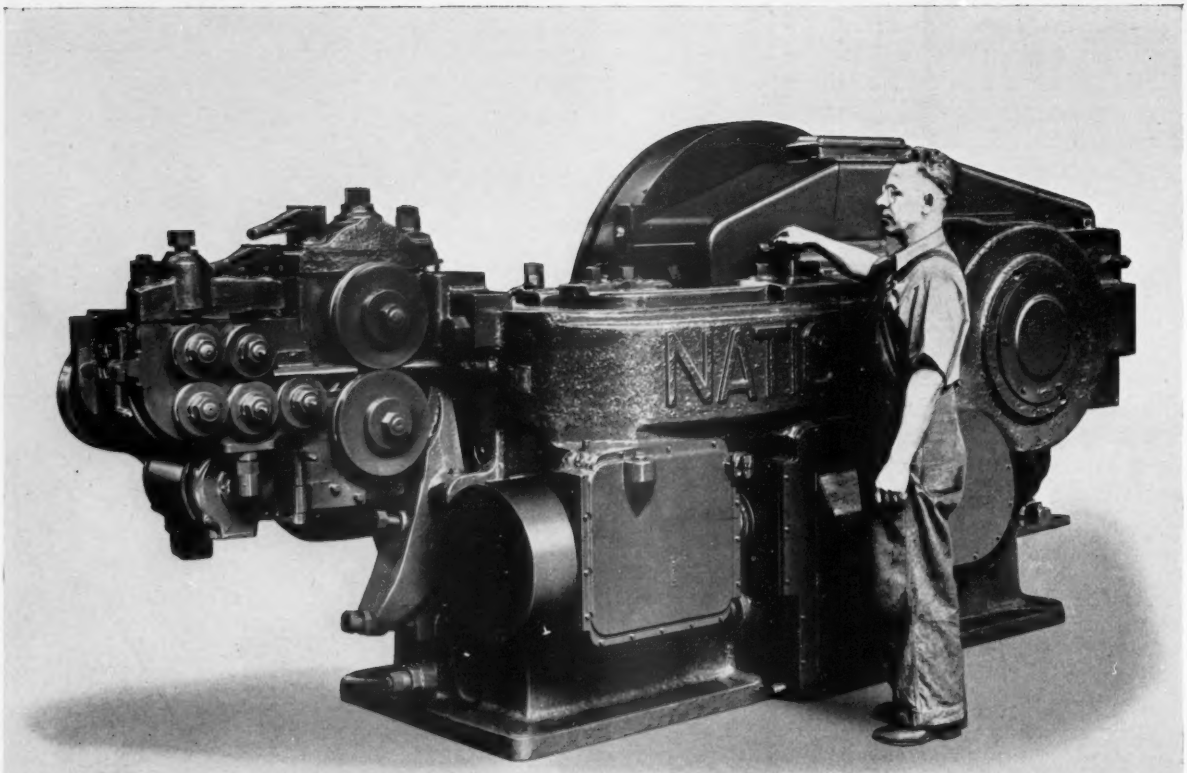

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Development of Apparatus for Shaving Copper Wire Commercially

By C. E. Weaver,
Development Engineer, Schenectady Works Laboratory,
General Electric Company, Schenectady, N. Y.

This paper primarily deals with a new and improved method of making "bull ring" wire, which is a wire usually rolled into rectangular sections and then insulated and fabricated for use in electrical apparatus. ✦ ✦

Bull Ring Wire

BULL ring wire was made and used long before the electrical industry had reached the stage of development where wire of this quality was demanded. Its name is descriptive. Copper rings for insertion in the noses of bulls had to be perfectly smooth and free of slivers and surface imperfections so that the bull would not be subjected to irritations other than those normally affecting him.

✦ ✦ ✦

BULL ring wire in the electrical industry differs from ordinary copper wire in that it is produced usually to be rolled into rectangular sections, which are insulated and fabricated into coils for motors, transformers, and other types of electrical apparatus.

✦ ✦ ✦

Wire Requirements for Insulated Conductors

IT is essential that wire to be used as an insulated conductor have a surface that is uniformly free from slivers and surface defects. Insulation failures are frequently traced to imperfections owing to the fact that slivers may wholly or partially penetrate the insulating material while the coil is being formed.

✦ ✦ ✦

THE elimination of these defects is a matter of grave importance to the manufacturer of wire, where it is necessary to keep his rejects and complaints at a minimum; also, to the apparatus manufacturer, who wishes to avoid expensive failures on the test floor and in service.

✦ ✦ ✦

WHEN it is realized that one sliver may necessitate the rewinding of a large power transformer or the dismantling of a turbine generator, the importance of smooth wire can scarcely be overestimated.

✦ ✦ ✦

Removing Slivers In Copper Wire Rod

UNTIL recently all copper wire manufactured in this country was produced from hot rolled rod. It is the hot rolling operation that is largely responsible for the surface condition of drawn wire. Slivers, rolled in fins, and other surface imperfections may become evident when the wire is cold drawn to the various required sizes.

✦ ✦ ✦

C. E. WEAVER
Development Engineer, Works Laboratory, General Electric Company, Schenectady, N. Y.

GOOD or bad hot rolling practice will, of course, be reflected in the quality of the drawn wire, but rod which has been rolled under the best possible condition and close technical control may still draw to slivery wire if it is not treated at some time after rolling to remove these surface imperfections.

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THE method in general use to remove these slivers and minor surface defects is to burn them off by annealing between drawing operations in an open fire furnace with the products of combustion adjusted to facilitate rapid oxidation. The grain growth characteristics of commercial copper make it advisable to limit the annealing or "open firing" temperature of the copper to 700 deg. C. At this temperature it is not possible to burn off or oxidize the surface to a sufficient depth in one pass through the furnace.

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AFTER the "open firing" the wire is quenched in a tank of water causing a sudden contraction, which causes most of the scale to fall off. It is then immersed in the pickling tanks where it is held until the remaining scale and oxide are either removed or reduced, and then washed thoroughly by high pressure streams of cold water, and rinsed in a tank of hot water to facilitate drying. A wire finishing operation is also sometimes necessary to remove copper powder if the scaling has been heavy.

✦ ✦ ✦

IT is necessary to repeat the above process of open firing and pickling between subsequent redrawing operations at consider-

able expense and loss in copper through incomplete recovery of the oxides.

✦ ✦ ✦

OXYGEN free copper recently introduced commercially can not be satisfactorily treated for bull ring wire by this process, as repeated open fire annealing destroys to some extent its oxygen free properties.

✦ ✦ ✦

REALIZING the above mentioned hazards and high cost of manufacturing copper wire to meet their exacting specifications, the **General Electric Company** established a development program and carried out an extensive investigation extending over a period of years to secure a less costly and more efficient method of removing the surface imperfections inherent in hot rolled copper rod. The start was made without much more than an idea, but with the knowledge that a better wire surface was necessary for many types of insulation and in many types of apparatus. It was known that attempts have been made in the past to mechanically remove the outer surface of copper wire. These have been mostly scraping processes, rather than a cutting, and were expensive both as to labor and die costs, and did not result in the type of surface desired.

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The Experimental Work

ORIGINAL trials were started in the Wire Department by **E. W. Clark** on an old heavy horizontal single block machine. It was soon discovered that an immense amount of research and developmental work would be required before an economical production process could be completed. As is customary in process developments, the Works Laboratory was requested to assist and the writer was assigned to finish the work. From this point the Works Laboratory, with the cooperation of the Wire Department, continued to work on the original machine.

✦ ✦ ✦

AFTER a preliminary study of the problems involved, the shaving die head was completely redesigned and work was started to determine the best type of shaving die to use by actual trial. Many types and shapes of shaving dies were tried until a fairly satisfactory shape was developed which could be manufactured and reground at reasonable cost. Changes in cutting die shapes, methods of manufacture, selection of steels and heat treating have enabled a standard to be reached which is now in use. It is now possible to shave 150,000 feet of wire without changing dies, and with an increase of hole diameter of less than .003 of an inch. Dies were made from all available cutting material before this was accomplished.

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ANOTHER difficulty developed when the shaving was perfected. It was found that the average cast iron draw block was not satisfactory. The shaved wire was so clean and so free from lubricant that is normally carried over on the somewhat porous surface of hot rolled rods that it would not slide along the block and soon grooved the block adjacent to the radius, also causing damage to the finished wire.

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HARDENED steel rings were tried with not much better results, so a stellite surfaced ring was designed and constructed, which material is now being used on all drawing blocks subsequent to the shaving head. Stellite has a low coefficient of friction, takes a high polish without cutting, and copper will not weld to its surface.

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WITH the above knowledge available, specifications were written for a heavy three block machine. Special draw blocks had to be designed to enable the stellite faced rings to be put on. Change gears were provided to enable the finishing block to be run at different speeds so that finished size could be changed as much as a die number without restringing through the shaving head.

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EVEN with this construction, difficulty was encountered with wire travelling up on the block. The wire was so clean and free from lubricant that it would not slip of itself and ride up properly on the block. A special fleeting device had to be developed to overcome this. The results have been more than satisfactory and the immediate acceptance and demand for shaved wire from our own plants have justified the development. The demand increased so that it became necessary to re-

3-Block Heavy-Wire Drawing and Shaving Machine in General Electric's Schenectady Works. ✦

build and equip another machine to take care of smaller sizes.

✦ ✦ ✦

Present Practice

FOR the production of bull ring wire a heavy continuous type of wire drawing machine is required. The number of dies or draw blocks needed, depend on the amount of reduction required to obtain the desired finished size. There are now two machines — one three block heavy machine capable of starting with 7/8" hot rolled rod and capable of a reduction of about 4½ AWG gauge numbers, and another lighter machine with six dies capable of 8 AWG reductions. With these two machines it is possible to finish any size of bull ring wire down to .150 in a single operation from some standard size of hot rolled rod.

✦ ✦ ✦

THE open fire annealing furnace has been scrapped, and the pickling and cleaning equipment relieved, which was overloaded, so that it can now be used entirely for cleaning rod as received from the rod mill.

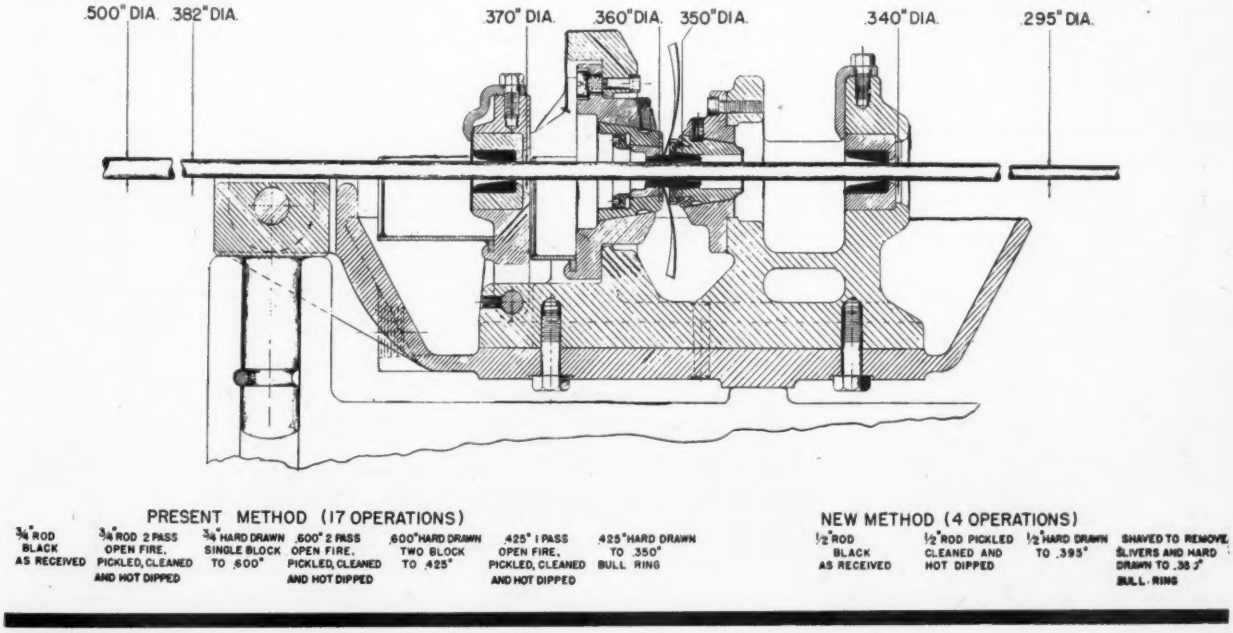
6-Block Intermediate-Wire Drawing and Shaving Machine in General Electric's Schenectady Works.

✦ ✦ ✦

IT should be noted that the shaving of the rod is, in addition to being a wire drawing operation, a machining operation requiring the development of an entirely different technique than that employed in ordinary wire mill practice. The two machines are now being operated by experienced wire drawers — one wire drawer and one helper to each machine. The operation and adjustment of the shaving head itself is relatively simple. The rod is delivered to the wire shaving machine in coils of cleaned rod. It is then welded into stacks, these stacks being placed on a two spindle swift, making it necessary to stop only after completion of one stack to weld it to the other. Building up stacks and welding are the responsibility of the helper.

✦ ✦ ✦

THE first end of the first stack is pointed and a conventional string-up follows. The machine is started and finished bull ring size is produced directly from rod, it being necessary only to stop the machine, cut off and tie up each 220 pound coil for convenience in future handling. There may be as many blocks and dies after the shaving head as are needed to finish a required size, or this can be obtained by subsequent redrawing.


.500" DIA.
.382" DIA.
.370" DIA.
.360" DIA.
.350" DIA.
.340" DIA.
.295" DIA.
PRESENT METHOD (17 OPERATIONS)
¾" ROD BLACK AS RECEIVED
¾" ROD 2 PASS OPEN FIRE, PICKLED, CLEANED AND HOT DIPPED
¾" HARD DRAWN SINGLE BLOCK TO .600"
.600" 2 PASS OPEN FIRE, PICKLED, CLEANED AND HOT DIPPED
.600" HARD DRAWN TWO BLOCK TO .425"
.425" 1 PASS OPEN FIRE, PICKLED, CLEANED AND HOT DIPPED
.425" HARD DRAWN TO .350" BULL RING
NEW METHOD (4 OPERATIONS)
½" ROD BLACK AS RECEIVED
½" ROD PICKLED CLEANED AND HOT DIPPED
½" HARD DRAWN TO .395"
SHAVED TO REMOVE SLIVERS AND HARD DRAWN TO .382" BULL RING

Set-up In Shaving Rod

THE setup in shaving rod is as follows. Starting with hot rolled and cleaned rod, anywhere from 1 AWG gauge number to 2¼ gauge numbers, reduction is taken on the first die, depending on the size of finished wire required. While it is desirable to shave at the largest possible diameter to save scrap and die wear, it is necessary to pass the rod through at least one die to insure its being round and reduce somewhat the thickness that it is necessary to remove to eliminate surface imperfections.

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THE shaving head is mounted between first and second blocks and consists of a rigid holder containing a drawing die, guide die, shaving die and drawing die, in the order given. The guide die is adjustable for centering the cut. The cut may vary from .004″ thick to .006″ thick, depending on size and condition of rod being drawn. A total reduction in diameter of about 1 AWG gauge number is taken in the shaving head. The shaving head holder is fastened to the machine by a two way swivel or universal joint so that it always lines up with wire pull.

✦ ✦ ✦

The Shaving Die

IN developing the shaving die, it seemed that no generally accepted rules that apply to standard cutting tools could be followed, as dies developed along these lines would not shave a continuous chip or shred from the surface of the rod without producing a torn or scuffed surface. Dies were tried with angles that extended all the way from scalping dies with faces at 90 degrees to the axis of the wire, to shaving cones with faces 45 degrees to the wire axis.

✦ ✦ ✦

THE present die is constructed with six flats ground upon the surface of the cone, which gives the cutting edge a slight scallop appearance and provides six leading chisel edges which separate the cylinder of copper slightly ahead of its removal from the surface of the rod. This produces six separate chips or shreds and eliminates the scuffing that had formerly appeared on the surface of the wire. It was found necessary to provide a means of adjustment between the guide die and shaving die so that the cut could be kept concentric. Even if these two dies were set absolutely in line, the chip would not come off evenly on all sides. However, after concentricity of cut is once obtained, it does not change during that particular setup.

✦ ✦ ✦

WHILE a satisfactory production basis in the manufacture of shaved wire has now definitely been established, investigations are still being made with the expectation of developing better methods of construction or better materials for the dies. Experience has shown that if additional drawing equipment is needed certain changes could be made in the drawing machines and in the die holders that would be of considerable advantage in machine operation.

✦ ✦ ✦

Summary

IN closing, it would be well to call to your attention the fact that the satisfactory development of this process has resulted in a very definite saving in cost and a very great improvement in the quality of so-called bull ring wire as manufactured by the GENERAL ELECTRIC COMPANY.

✦ ✦ ✦

MANUFACTURING operations have been reduced in the ratio of about one to four, and the time required to produce in about the same ratio.

✦ ✦ ✦

SERVICE to customers has improved, especially on emergency orders, and while we do not sell bare copper to the trade, this factor alone has been of great assistance to our own apparatus manufacturing departments in improving service to their customers.

✦ ✦ ✦

THE development cost has been considerable, but it is felt that it has resulted in a distinct improvement in the art of producing at least a definite type of copper wire. That the cost of development was justified has been evidenced by the willingness of the various apparatus manufacturing divisions to absorb their share of that development cost.

✦ ✦ ✦

PATENT application covering this process has been made and many claims have been allowed.

✦ ✦ ✦

Acknowledgement

Acknowledgement is made to the following men for their assistance in this development:

E. W. Clark and Frank Ponzillo, Manufacturing Department.

R. W. Clark and L. B. Barker, Works Laboratory.

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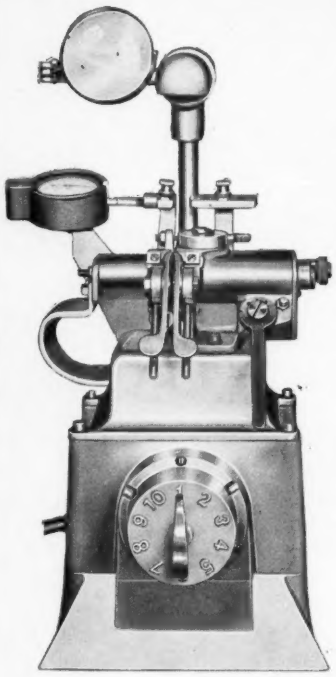

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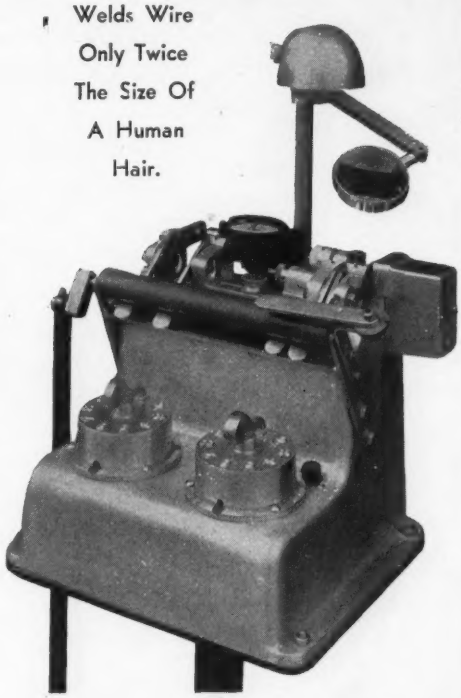

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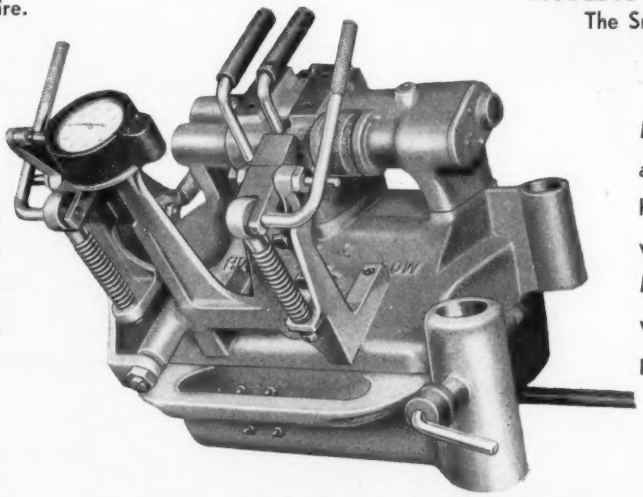

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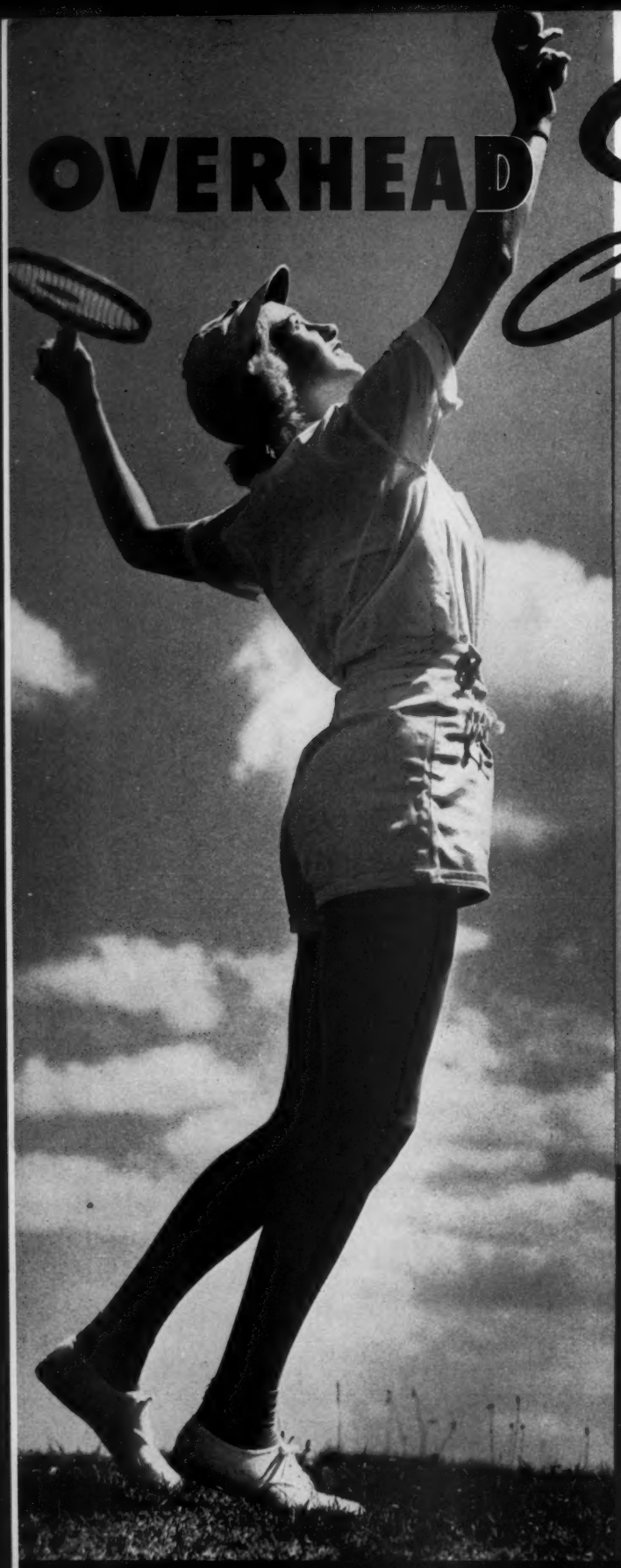

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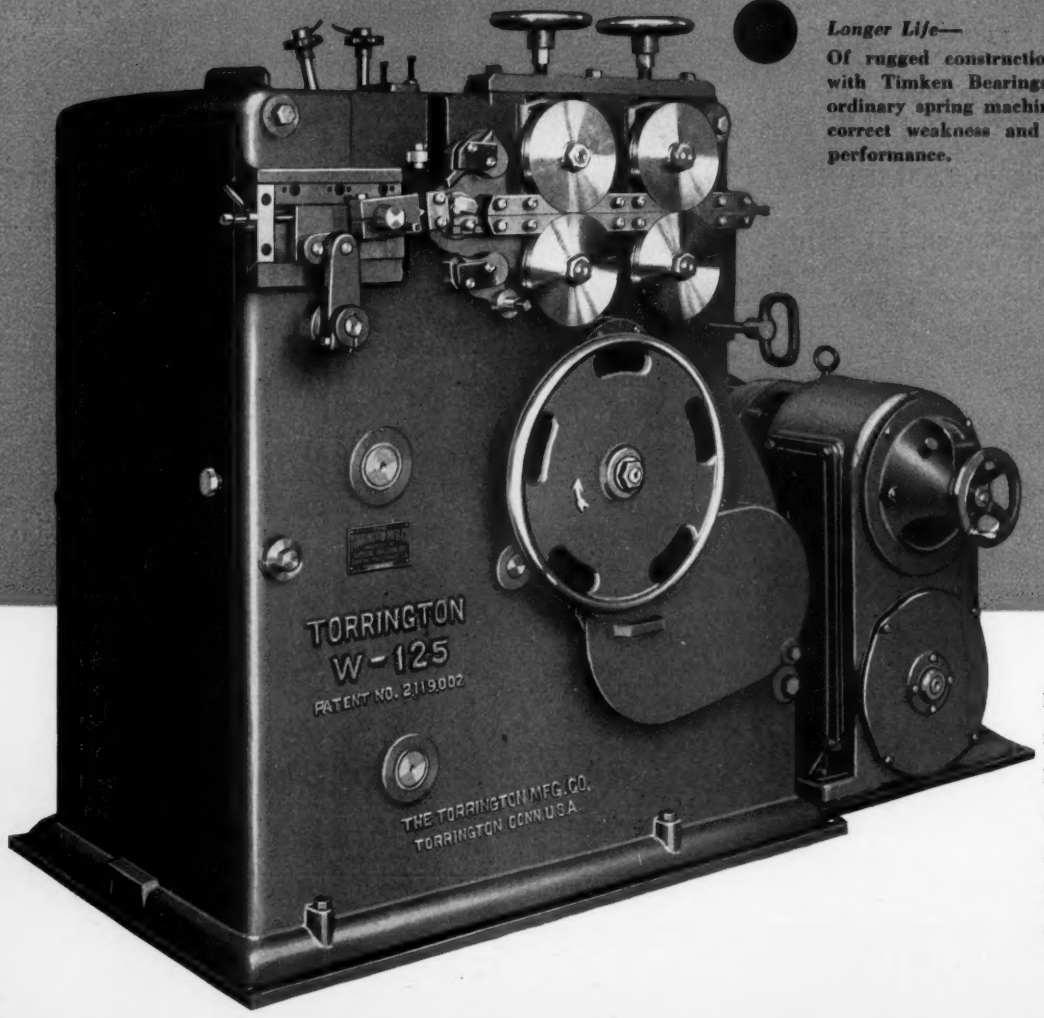

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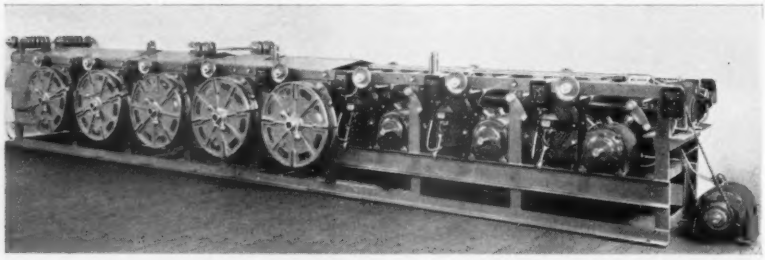

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Lime For Wire Drawing

By D. E. Washburn,
Chief Chemist,
American Lime & Stone Div., The Warner Company, Bellefonte, Pennsylvania.

The author contends that the chemical analysis of a high calcium lime within liberal limits, except for the MgO content has very little control over the type of coating produced. It is hoped that this discussion will contribute towards a better understanding of high calcium lime in wire drawing.

LIME for wire drawing serves a dual purpose, namely, it functions as a neutralizer of acid subsequent to pickling and also as a dry lubricant in the drawing process. Probably the word "lubricant" is the wrong word to use, but at any rate the lime coating apparently in some manner helps reduce the friction between die and wire, which otherwise would be present to cause trouble and disrupt operations in many cases of wire drawing. In short, therefore, lime serves both as a chemical and physical agent in the wire drawing industry. In this respect the use of lime for drawing wire differs from its uses along many other lines when it serves for the most part the single purpose of neutralization. For most industries the value of any high calcium lime is dependent on its neutralizing power. Either directly or indirectly this basic property determines its value, and because of its abundance and wide distribution, lime constitutes the cheapest basic material serving our modern industries.

✦ ✦ ✦

IN the wire drawing industry the amount of lime consumed for strictly neutralizing purposes must be rather insignificant, for most certainly after the wire leaves the acid bath and is thoroughly rinsed with water, there can't be much acid left to neutralize. To a lime chemist, this brings up the question as to why a high calcium type of lime is apparently preferable to a high magnesium or dolomitic form of lime. Theoretically, and for neutralization purposes, the more MgO a lime contains, the higher its neutralizing value should be, because according to their molecular weights, 40 unit weights of MgO should do the same work as 56 unit weights of CaO. Also, from a theoretical viewpoint, MgO should constitute a more effective neutralizer of sulfuric acid, because the magnesium sulfate formed is a soluble compound, whereas calcium sulfate in comparison is very insoluble. In the final analysis, therefore, the general preference for a high calcium lime must be almost entirely due to the favorable physical characteristics imparted to lime coatings.

D. E. WASHBURN

Born White Haven, Pa., March 3, 1883. Graduated from White Haven High School in 1901. Studied chemistry at the Pennsylvania State College and graduated, receiving degree B.S., in 1906. Accepted position as open hearth chemist with American Steel Foundries Company at East St. Louis, Mo. In 1909 became assistant chief chemist with same company at Granite City, Ill. In 1912 took charge of the laboratories of the Bellefonte Iron Company and Nittany Iron Company, Bellefonte, Pa. Became chief chemist of the American Lime and Stone Company in 1921, until Warner Company, Philadelphia, assumed control in 1922, since which time he has been chief chemist and technical sales representative of the Bellefonte Division of the Warner Company.

✦ ✦ ✦

IT is the contention of this discussion, therefore, that the chemical analysis of a high calcium lime within liberal limits, except for the MgO content, has very little control over the type of coating produced. This is not meant to imply that the impurities present, such as silica, iron, and aluminum oxides can be present in unreasonable excessive amounts without affecting the coatings, but they can be present in a much wider range than is generally appreciated.

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TAKE the item of silica for example. The first impression striking one's mind on the mention of silica is that of an abrasive substance, such as sand or quartz, which if present in a lime coating in any size would raise havoc with the dies and wire. Yet there are forms of silica, such as are found in kieselgur, diatomaceous earth, etc. which are almost amorphous. Such a material is virtually nothing more than a mild polishing agent, so that its presence in a lime coating would have no appreciable destructive action.

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ALL our limestone deposits contain varying amounts of silica. This silica for the most part is present in the form of quartz, sand, or combined with iron and alumina to form clays, or with other ele-

ments to form different varieties of felspars. There is very little chance, however, of any of it being present in an amorphous state, except in very minute quantities and in very rare instances, and even if it were, the process of manufacturing the limestone into lime would change its form.

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IT might be well to dwell a little on the process of manufacture and its effect on the silica content of the limestone. For the manufacture of lime, the limestone must be heated up to at least 2200°-2400° F. in order to produce lime in commercial quantities. Under such conditions silica combines with the CaO and small amounts of other elements to form complicated silicates, and while we have some knowledge of the simpler form of silicates formed, we have very little of the intricate combinations which are found under poorly controlled temperatures. Through constant observation we do observe a fluxing action which we assume is for the most part a combination of silica and CaO to form some form of calcium silicate—a very abrasive substance. It is very probable that some combinations are very less abrasive than others, and under extremely high temperatures a very small amount of silica is capable of uniting with relatively a much larger amount of CaO to form highly abrasive combinations. Under such conditions small amounts of silica can be responsible for more abrasive contamination than their low analyses would seem to warrant. Conversely, a limestone containing much larger amounts of silica, but subjected to a lower and better temperature control, might result in a minimum of abrasive contamination.

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NOT only is it probable that these various combinations of SiO_2 and CaO due to temperature variations reflect themselves in the amount and character of the abrasive contamination, but it is also very probable that in a large measure they influence other physical properties of lime coatings, such as texture, adhesion, and quantity. These first two properties might have some bearing on the wear of dies and smooth operations, while the quantity of coating produced naturally influences costs as to materials involved. Taking all this into consideration, the item of silica, while considered an impurity, may or may not be a serious offender, all depending on the treatment the lime received during its manufacture.

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WHAT has been stated about SiO_2 in its relation to CaO is to a lesser degree true about the impurities Al_2O_3 and Fe_2O_3, as these items are usually present in lesser amounts.

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EVIDENTLY, therefore, it is dangerous to put too much confidence in the analysis of a high calcium lime as a measure of its value, except possibly as to its MgO content. Here is an item which very seriously effects the quantity of coating produced, as well as the physical properties thereof, and yet there appears to be some wonderful dolomitic limes of exceptionally low impurity contamination, which on slaking produce unsurpassable putties as far as texture and smoothness are concerned. Some of these limes are so excellent in these properties that they enjoy almost a virtual monopoly for certain types of high class construction, and yet for some reason they never have found favor with the wire drawing industry. It is possible that milks of lime made for such limes settle so erratic that it is difficult to secure uniform lime coatings. Nevertheless, it might pay some interested parties to do some research with these types of limes.

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CHEMICAL analysis, therefore, is not a sure criterion by which to judge a quick lime for wire drawing. It has been the author's experience that on investigation of complaints allegedly due to lime, that in no instance did the chemical analysis definitely establish the cause of the trouble. There is one instance which comes to mind where lime coatings flaked off and where a chemical analysis of the lime was exceptionally good, and better than the prior shipment of the same brand which worked perfectly. Changing back to some of the previous consignment still in stock corrected the trouble. Apparently the lime was at fault on account of some physical defect, but no doubt a long investigation, including microscopic studies, would have been necessary in order to get even a semblance of a clue.

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IN a previous discussion the author described in detail the process of lime manufacture, giving an outline of the various types of kilns employed and the effects of extreme temperatures on the physical properties of the lime and the milks of lime produced therefrom. At that time considerable experimental work was being done by the lime manufacturer with the use of powdered coal as a fuel in rotary kiln operations, and the statement was made to the effect that while the coal burned product then produced was not up to the standard of a gas burned product, yet through experiment and research it might be developed to a degree where it would stand on a par with the gas burned quick lime. To date there are a number of instances where such is virtually a fact. The problem of controlling temperatures, and the prevention of coal ash from fusing with the lime has been largely overcome, and the physical properties such as would effect lime coating for wire drawing have been markedly improved. Mention is here made of this development in order to keep you advised of the efforts the progressive lime manufacturer is making to economize and at the same time increase the quality of his product.

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MAINTAINING the proper standards of quality in the manufacture of lime in order to meet the requirements of a lime coating requires constant plant supervision, selection of product, and controlled processing. In fact, there are a number of industries employing high calcium lime where

the lime manufacturer is required to specialize more or less in order to meet requirements, and the wire drawing industry constitutes one of these. A number of years ago there appeared to be only one reliable source of lime in the East for wire drawing. This particular source had a limited supply of exceptional limestone, which when subjected to wood burning produced an unsurpassable product. Unfortunately this limited source of limestone became exhausted so that the wire industry was compelled to look for another source of supply. Naturally, a number of lime manufacturers got busy on the matter and through their efforts developed a dependable product. Speaking on behalf of some of these manufacturers, it can be stated that they are constantly making studies to still improve their products. In spite of all this, you should bear in mind that you are dealing with an unstable product. The minute a high calcium lime is exposed to the atmosphere it begins to hydrate and recarbonate. It is true that sealed packages prevents most of this until the lime is delivered, but the minute the lime is slaked for use the process of recarbonation begins, and proceeds very rapidly. Accordingly, lime tubs should be frequently cleaned, as the carbonate formed does not possess the binding or adhering properties of calcium hydrate, and it is only reasonable to assume that negligence in the matter may lead to deficiency of binder in the coating to cause poor adherence and flaking.

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AS a rule, when a coating fails and it is allegedly due to the quality of the lime employed, it is impossible to definitely ascertain exactly what element in the lime is the cause of the trouble. After all, the molecular structure of the lime must be rather complex and possibly some slight variation in temperatures or pressure during its manufacture might occasionally cause molecular combinations to alter physical properties. You can readily see, therefore, that it might require X-ray studies to finally determine the ultimate causes. Incidentally these very X-ray studies are at present going on in order to determine if some light can be shed on the causes for the different physical phenomena in lime and lime products.

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IT is hoped that this rather short discussion will contribute at least to a small degree toward a better understanding of the use of high calcium limes in wire drawing.

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Electrochemical Applications In The Wire Industry

By C. L. Mantell, Ph.D.,
Consulting Chemical Engineer and Metallurgist,
New York, N. Y.

Electrochemical applications to wire and wire products are many and diversified including coloring, cleaning, pickling, plating, the deposition of non-metallic coatings and coverings. Concise descriptions of many processes are given here. ✦

IN the field of wire drawing per se, electrochemical applications are largely limited to electrolytic cleaning, electrolytic pickling applied to all types of wires, electrolytic polishing largely employed in connection with alloys of the so-called stainless variety, and electroplating, particularly in the form of electrogalvanizing. Electrolytic cleaning, pickling, and polishing were discussed in the August, 1940, issue of **Wire and Wire Products.**

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WHEN the wire field is thought of in terms of wire products, a number of additional electrochemical applications are found. These involve anodic (or positive electrode) oxidation, particularly applied to aluminum and its alloys; electrolytic coloring, producing a wide variety of shades but probably of major interest in connection with copper, brass, and related alloys; electroplating, involving most of the known metals; anodic deposition of rubber; and the electroplating of resinous products from emulsions. These will be briefly discussed.

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THE electrochemist refers to current density, or amperes per unit of surface of the object being treated; current concentration, or amperes per cross-sectional unit of the conducting medium or electrolyte; anodes, whereby he means the positive or plus electrode; and cathodes, the negative electrode. The electrochemist in many plating and coating operations refers to throwing power, which is a relative term describing the ability of the particular electrolyte to allow deposits of metal to be plated or "thrown" into recesses or around corners. Good throwing power is often important in connection with the coating of intricate wire shapes. The coatings themselves are referred to as decorative where they serve this purpose without any thought of resisting corrosion, or protective where they are applied as a type of permanent finish which enhances the resistance of the object to corrosive influences.

✦ ✦ ✦

CHARLES L. MANTELL

Ph.D. is a member of the American Institute of Mining and Metallurgical Engineers, American Institute of Chemical Engineers, American Society for Testing Materials, American Society for Metals, The Electrochemical Society and the American Chemical Society. He was educated at McGill and Columbia Universities. After army service, he was connected with the Aluminum Company of America. Since 1924 he has been a consulting engineer and has been responsible for the design of metallurgical and electrochemical plants in many portions of the world. He is the author of over a hundred technical publications and volumes.

Anodic Oxidation

PROTECTIVE adherent oxide films can be produced anodically on aluminum and its alloys for protection against corrosion, for electrical insulation, for decorative effects, and for other uses. These can be dyed, painted, oiled, or otherwise treated. A number of different methods have been devised.

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WHENEVER aluminum is made in a suitable electrolyte, an oxide film is produced on the metal. The properties of the oxide films are affected by many factors. Among these are the composition of the metal or alloy undergoing treatment, the constituents and their proportion in the electrolyte, as well as the temperature of the bath, and the electrical factors such as current and applied voltage. The color of the coating, its rate of formation, and its resistance to corrosion may be controlled by the composition of the metal.

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THE electrolytes proposed in the patent literature have been many and varied. Few of these have found industrial application. Among those proposed may be mentioned ammonium hydroxide, ammonium sulphide, borates, phosphates, tartrates, oxalates, and the corresponding acids, chromic acid, chromates, sulphuric acid and sulphates, as well as many others. The applied voltages may vary from only a few volts to as high as 500 or greater. The colors of the coatings on aluminum metal itself may range from white to gray, depending upon how it was formed; on aluminum-silicon alloys it is gray to brown, and on aluminum-copper alloys it may have a greenish cast. The appearance of the

coating will also be a function of the initial surface of the aluminum, which might be all the way from a highly polished metal to one with a sandblast finish.

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OF all the methods proposed, the only ones which have found widespread use have been those with chromic acid electrolytes or sulphuric acid electrolytes. The former are applied for the preparation of coatings which are highly resistant to corrosion, while the latter are employed for the development of colored aluminum finishes. The chromic acid method is a more expensive and time-consuming operation. The sulphuric acid procedure is capable of rapid application in a simple manner with the usual plating equipment.

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BENGOUGH and his co-workers recommend a 3 per cent solution of chromic acid free from sulphates or sulphuric acid. The cleaned object as anode is subjected to a voltage which is gradually raised from 0 to about 50 volts over an hour's time. For airplane and dirigible parts, the time cycle is 0 to 40 volts in the first 15 minutes. The voltage is maintained at 40 volts for 35 minutes. It is then increased to 50 volts over a period of 5 minutes and maintained there for another 5 minutes. The object is removed, washed, and dried in the usual manner. For maximum protection against corrosion, the oxide coating is strengthened or reinforced by the application of grease in thin layers.

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IN the sulphuric acid method, the electrolyte consists of dilute sulphuric acid with small quantities of other chemicals to improve the properties of the anodic coating. The process may be divided into three stages: cleaning, anodic oxidation, and washing and dyeing. After cleaning, the piece is washed in water or in the case of some aluminum alloys, such as those containing copper, washed in dilute nitric acid. It is then hung as anode in the electrolytic cell.

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IN the electrolytic oxidation procedures, throwing power of the bath is not important nor are shaped cathodes required. The oxide film, which has an appreciable electrical resistance, first builds up on the portions of the anode nearest the cathode. There formation stops when the film resistance builds to a point where the electrolytic action is transferred to unoxidized surfaces. Eventually the whole object is covered with oxide.

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ACID concentration of the electrolyte may be varied from 10 to 70 per cent and the time of treatment 10 to 15 minutes. By the selection of proper acid concentration, time of treatment, and voltage, it is possible to produce anodic films on aluminum and aluminum alloys, which films are flexible enough to withstand bending, pressing, deep drawing, stamping, and further fabrication. With other acid concentrations, treatment times, and higher voltages, very hard oxide films may be formed on fully manufactured products.

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DYEING is usually done with aqueous solutions of organic dyestuffs, the dyeing being done immediately after the electrolytic treatment and washing. If the film be allowed to dry, microscopic pores in it become filled with air, and the dye solution does not readily penetrate. The dye baths are operated at 75 to 80° C. (167 to 176° F.), and the dyeing time is 10 to 20 minutes. The articles are then washed until they no longer give up any dyestuff. The dyestuffs are believed to form "lakes" with the aluminum oxide and are thus precipitated in the film.

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Metal Coloring

CRAIG and Irion[1] produced rapid patinas on copper and its alloys[2] by employing alkali carbonate electrolytes at current densities of 9 to 185 amperes per sq. ft. with copper as anode to form basic carbonate coatings which were adherent and protective. **Stareck and Taft**[3] used alkaline solutions of copper lactate to produce Cu_2O anodic colors in a range of shades at current densities of 1.4 amperes per sq. ft. at 0.25 volt. **"Electrocolor"**[4] uses copper anodes in a copper ion electrolyte to deposit Cu_2O in a wide range of colors whose shade and depth are a function of time and current density. On different metals violet, blue, green, yellow, orange, and red may be produced. Zinc plated or galvanized wire may be anodically colored[5] in phosphates, ferro — or ferricyanides, permanganates, chromates, oxalates, and molybdates whose solutions are maintained at a pH of 6 to 8.[6]

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Electroplating

WIRE and wire products are plated with a wide variety of metals either alone or in combination by successive procedures. As is well known, aluminum and magnesium cannot be electroplated on steel and other base metals from aqueous electrolytes. Experimental plating of these metals from solutions of organic salts is only of scientific interest at present. Antimony has found no commercial applications, and the same holds true of bismuth. Cadmium plating, however, for both decorative and protective effects is widely used, being plated from a complex cyanide solution. The same holds true of chromium, which, however, is seldom plated directly on steel but over a plated layer of copper or nickel or combinations of both. Although it should be of interest because of the ease of plating, cobalt, due to its high price, finds little application.

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IN wire drawing itself, copper is often used as a lubricant on steel, but the copper coating is generally applied by displacement in that some iron of the steel goes into solution and copper is deposited generally from an acid

[1] **Metals and Alloys, 6, 35 (1935).**

[2] **U. S. Patent #1,974,140.**

[3] **British Patent #452,464.**

[4] **Trademark of United Chromium, Inc.; Stareck, U. S. Patent #2,081,121.**

[5] **New Jersey Zinc Co., D.R.P. 626,502, Feb. 27, 1936.**

[6] **New Jersey Zinc Co., D.R.P. 623,563, Dec. 28, 1935.**

bath. On fabricated wire parts, however, there is widespread application of copper plating, particularly from the cyanide bath, so that bright deposits may be produced, or else the copper is employed as an underlying coat for other metals. Gold plating in a variety of shades is in practically all of the wire plants making pieces or articles for the costume or novelty jewelry trade.

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INDIUM and iron can be readily plated, but find little application in connection with wire. The same holds true for lead. Nickel in contrast is found in a large number of places in both protective and decorative finishes. In order that polishing of intricate shapes be avoided, the so-called bright or lustrous platings, made as the result of either cobalt additions to the electrolyte or the use of organic acids as the base of the solution, are found in many plants making wire articles. Some duplex or composite wire is made by electroplating a drawn wire with another metal and then subjecting the composite to further drafting.

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THE precious metals, palladium, platinum, and rhodium, may all be plated, but price limits their use. Silver-coated wire or wire articles are made for specialized purposes, particularly in the electrical field. While tin can be quite readily plated and electrotinning finds employment in competition with hot dip tinning, at the present time in the wire field most tin-coated wire is produced by hot dipping or by pickle liquor methods in which chemical displacement of the tin from solution with deposition of the tin on the wire occurs. An interesting application for protection of wire and wire parts against hydrochloric acid is found in tungsten and tungsten alloy plates.

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PERHAPS of greatest interest to the wire industry is zinc plating or electrogalvanizing. This procedure is really an application of electrolytic zinc manufacture. In most platings, with the exception of chromium, the metal to be deposited on the article being plated comes from a soluble anode. These are replaced as they are consumed. In the most widely used electrogalvanizing procedure, zinc ore is roasted and the calcined product treated with sulphuric acid solutions to dissolve the zinc. These solutions are purified and sent to the electrogalvanizing cells. Instead of having the zinc deposited on a plate cathode to form electrolytic zinc, the metal is deposited on carefully cleaned iron wire. It thus follows that the zinc from the mine to the farm of the user of the galvanized wire has never passed through the metal stage nor has it ever been melted. This is in marked contrast to dip galvanizing.

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COILS of iron wire are butt-welded together for continuous zinc plating. The wire to be galvanized is cleaned cathodically in fused caustic. Sodium metal is liberated, which removes all non-metallics such as silicon, sulphur, and phosphorus. The iron oxide is reduced to the metallic iron state. The caustic pickle tank is a steel pan 20 ft. long, 24 in. wide, and 12 in. deep. Raw material consists of roasted concentrates containing about 69 per cent zinc. The zinc is dissolved in spent electrolyte (25 per cent sulphuric acid) from the cells. The residual iron, silicon, lead, etc., and the resultant solution are purified free from copper, cadmium, cobalt and the like by treatment with zinc dust. The zinc solution is drawn into the plating cells at the same speed that the zinc is removed from the cells by the plating action; four cells each take 15,000 amperes at 4 volts. The steel, lead-lined cells are 55 ft. long with 8 wires in each cell. Because of the approximately 2,000 amperes per wire, contacts (lead with 1 per cent silver) are provided every 3 feet to prevent the total current from flowing through any one point of the wire and melting it. Deposition of 1 ounce per sq. ft. in about 45 seconds is realized.

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THE zinc deposit is of a mat or crystalline type which is smoothed and compressed by rotary polishers before coiling. Coatings are made up to 4 ounces per sq. ft. for wire that is to be drawn down into finer sizes such as screen wire. At some plants the wire is annealed in a gas-fired furnace to burn off the grease, passed through the acid and anodic pickling and into the 110-foot plating cells drawing 40,000 amperes each, 12 wires being plated simultaneously, and then passed through dies to brighten and to densify the surface. The electrolyte to the cells contains 200 grams of zinc per liter and 200 to 270 grams of sulphuric acid per liter. The current density on the cathodes is of the order of 700 to 2,000 amperes per sq. ft., at which current density a large gas evolution occurs. The anodes are lead-silver alloys. The wire travels at a rate of 50 to 200 feet per minute.[7]

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THE process allows the use of low-grade concentrate carrying 30 per cent zinc. Electrogalvanizing as compared to hot dipping shows less of the bonding zinc alloy, a brittle constituent causing failure of the coating owing to breakage or cracking of the bond. Silicic and cresylic acids are used on top of the plating tanks as a prevention against the acid spray. A typical cell is illustrated in Figure 1.

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FOR purposes of color, alloys are often plated. The copper-zinc composition known as brass is in common use. For specific compositions and conditions of plating, reference should be made to the chapter on electroplating and electroforming in **Mantell "Industrial Electrochemistry,"** second edition 1940, published by **McGraw-Hill Book Company, Inc.,** New York, pages 187 to 221.

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IT is desirable to finish many wire articles either with soft resilient materials such as rubber for its protective value or its electrical resistance, or with resins to impart colors, gloss, or finish. The upside-down operation of rubber deposition, where the object receiving the coating is the anode rather than the cathode, is popular

[7] **The Iron Age, April 23, 1936, p. 44.**

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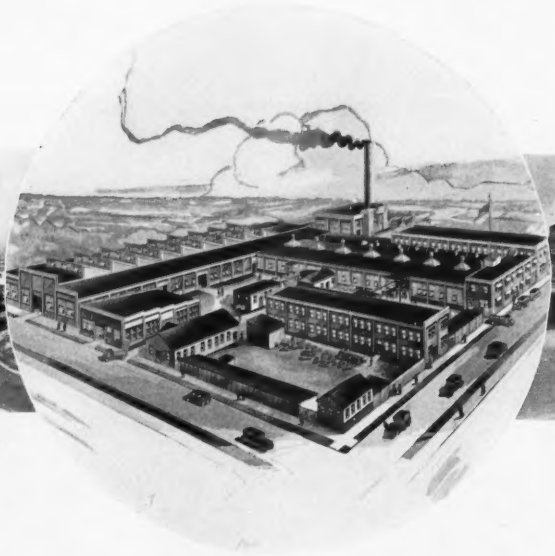

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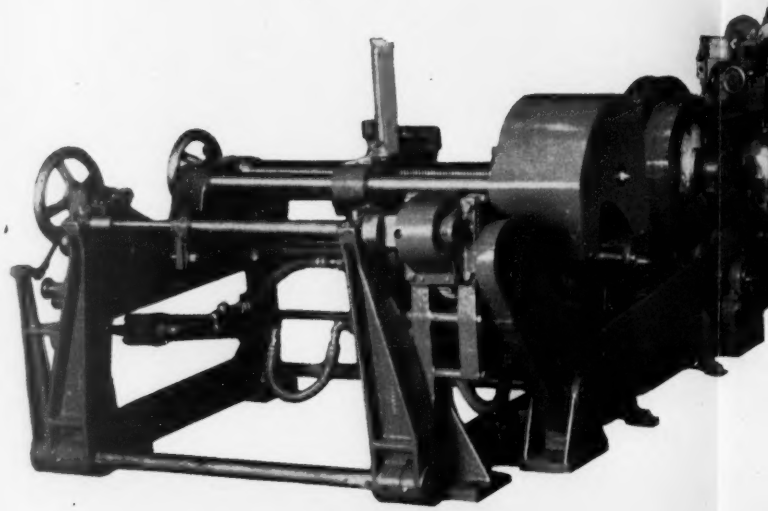

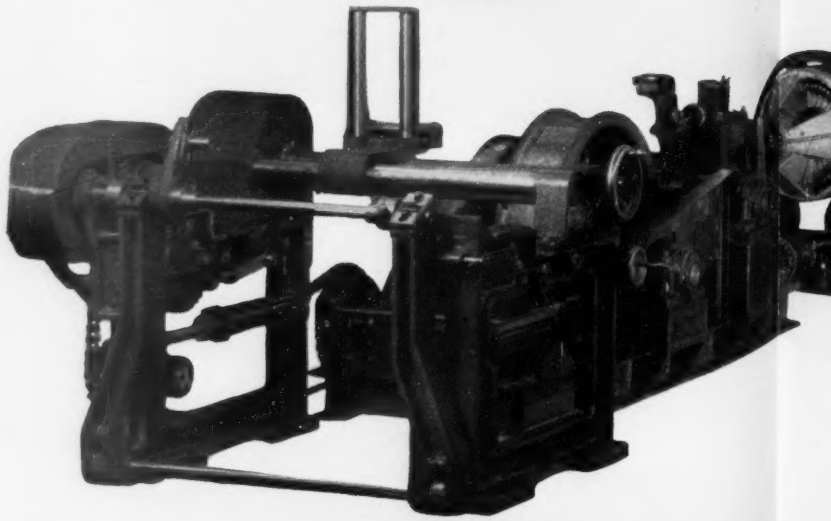

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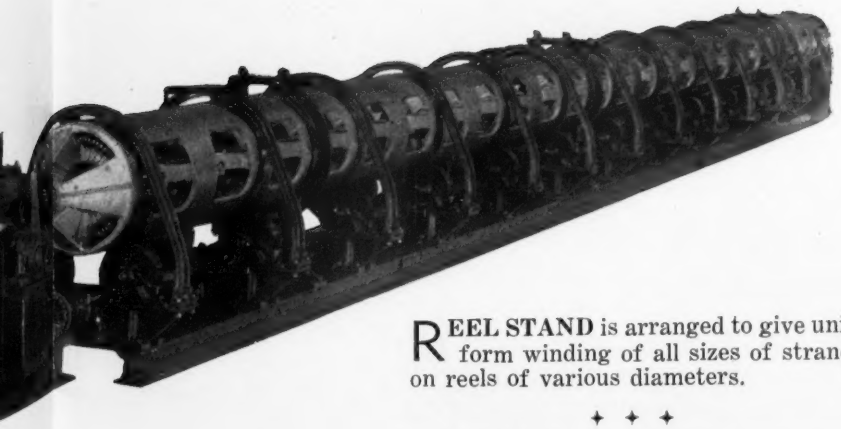

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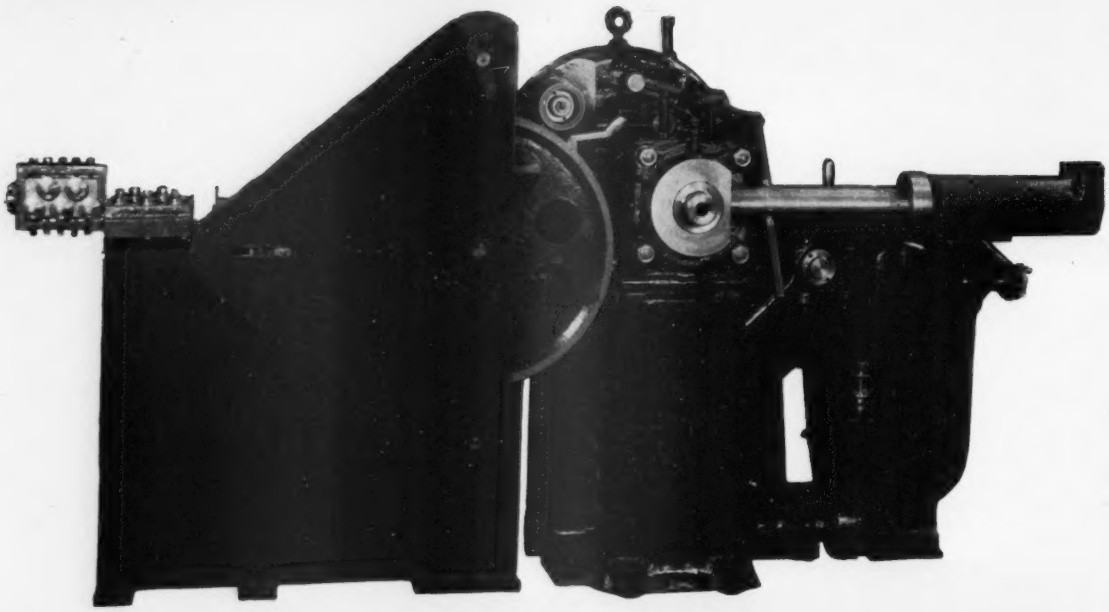

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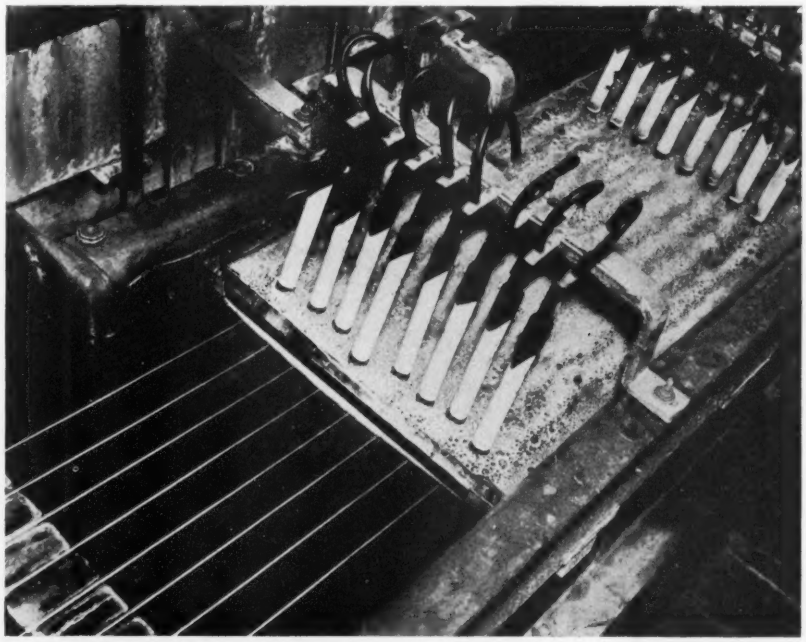
for wire racks, separating mechanisms, dish holders, and similar objects. Rubber latex behaves as a typical negatively charged colloid, coagulable by positive ions and, in an electric field, transportable toward the anode. **Sheppard**[8] has shown that latex particles, when no current is applied, are in active Brownian movement, but under the field of a uni-directional current the particles move toward the anode, with reversal of movement if the polarity of the field be reversed. Under uni-directional electric fields, particles deposited on the anode build up multi-particle layers. **Sheppard** is of the opinion that there is a substantial identity in the processes involved in the electrical transport of matter in solutions, colloids, emulsions, and suspensions. Metals which are capable of anodic corrosion and form stable oxides compatible with the rubber deposit are preferred as anodes. With such anodes, oxidative changes of the latex particles adjacent to the anodes are largely avoided. Zinc anodes have been found to be most useful, but copper anodes produce cuprous ions which lead to a very rapid breakdown of the rubber. Sulphur, fillers, pigments, and softeners in finely divided form can be added to the latex suspensions, and the mixed "compounds" can be electrically deposited uniformly and substantially in the proportions in the mix. The thickness which can be deposited is not necessarily limited, but from a practical viewpoint it is restricted by the question of drying and by secondary changes in the surface layers.

[8]**Trans. Am. Electrochem. Soc., 52, 52 (1927).**



Electrogalvanizing at High Speeds. Courtesy—Bethlehem Steel Corp.

RUBBER produced by electrodeposition may be readily vulcanized. It also permits the use of so-called superaccelerators, which cannot be used in milled stock because they act so rapidly that scorching results. The tensile strength of electrodeposited rubber is exceptionally high. Salts and hygroscopic bodies are readily washed out upon completion of electrodeposition, resulting in a product of high insulating properties.

✦ ✦ ✦

WITH large particles, the current efficiency of deposition of rubber is very high. A comparison with the electrodeposition of metals shows that at a current density of 10 amperes per sq. ft. (1.08 amperes per dm.^{2}), approximately 2.5 hours would be required to deposit 1 ounce of nickel per square foot (30.5 grams per dm.^{2}), while, taking the low value of 2,000 grams per faraday, this weight of 50 per cent rubber could be deposited at 80 amperes per sq. ft. (8.6 amperes per dm.^{2}) in 17 seconds; at the same current density 68 times as much rubber could be deposited in the time as nickel. At the higher concentrations of rubber (upward of 25 per cent) the comparison is still more striking, the amount of rubber being deposited becoming 100 to 300 times the amount, say, of zinc for the same current.

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THE throwing power in the electrodeposition of rubber is not very high, owing to the low conductivity, but is apparently higher than would be expected considering this factor. It is generally sufficient to take care of recessed angles, edges, and bends. The factors in throwing power of rubber latex baths probably differ in some respects from those in metal-plating solutions and are under investigation.

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IN commercial application metallic anodes are coated with porous materials, for example with a fabric or with gelatin, or surrounded at a distance by a porous diaphragm and the rubber latex including compounded dispersions is electrolyzed, with the resultant deposit of rubber upon the membrane or diaphragm. Voltages range from 10 to 100, depending upon the current density, size and shape of the article plated, the diaphragm resistances, and related factors.

✦ ✦ ✦

WHEN resinous substances are emulsified in aqueous solutions, they may be plated out of these solutions in a manner similar to that employed for rubber. After plating, the resin coatings may be baked or heated to complete their polymerization and conversion to insoluble bodies. As yet this field has been little explored.

Electric Patenting, Tempering And Annealing of Steel Wire

By John P. Zur,
Metallurgical Engineer,
The Trauwood Engineering Co., Cleveland, Ohio

Recent developments in Electric Direct Resistance continuous heat treating equipment would indicate the production of much finer grain structure than by conventional methods of treatment and with no surface decarburization and practically no scale. A description of the methods and equipment used is presented here. ✦ ✦ ✦ ✦

STEEL in the form of wire and strip has found a multitude of applications in our present day industrial and economic setup. It plays an important part in our every day lives, and has enabled us to make our existence more comfortable, and more secure.

✦ ✦ ✦

YET it would not be possible for us, to adapt steel, in the form of wire and strip, to such a variety of uses, each requiring definite combinations of physical or fatigue properties, were it not for the fact that we can vary the physical properties of steel wire and strip over an extremely wide range by modifying and controlling its composition, heat treatment, and processing operations.

✦ ✦ ✦

HEAT treatment, especially, provides a means of altering the physical properties of steel wire and strip, between extremely wide limits. Proper and uniform heat treatment makes it possible for us to best adapt a steel wire to a particular application, or a subsequent operation. Present day uses of steel in any form, call for the optimum qualities of the steel, and increasingly rigid specifications demand that heat treating operations impart to the steel, the proper combination of strength and ductility, together with uniformity, and good surface condition.

✦ ✦ ✦

FOR a long time we have known that steel, after being heated to a high temperature, becomes hard if cooled rapidly, and becomes soft if cooled slowly. Over a period of years we have made use of this characteristic, and have developed through practice and research, a series of heat treatments which best adapt a given steel to a particular purpose or use. In such a way there has been evolved the heat treating operations now referred to as hardening, tempering, patenting, annealing, normalizing, spheroidizing, etc. Each of these treatments has its particular application, depending upon the composition of the steel to be treated, and the purpose for which it is to be used.

✦ ✦ ✦

Conventional Heat Treating Practices

CONVENTIONAL heat treating practices for steel wire and strip, fall into two general classes; batch treatments where the wire or strip is treated in coils, or bundles; and continuous strand treatments, in which case the material passes through a heating media in a continuous strand and is subsequently quenched or cooled at a predetermined rate, depending on the treatment desired.

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OF these two methods of treatment the continuous strand heat treatment for obvious reasons produces the more uniform and desirable material. Batch treatments are resorted to only where the cycle of operations, that is, the time required for treatment, is prolonged and therefore does not lend itself readily to continuous strand practice.

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IN the usual continuous practices for the patenting, tempering, annealing, etc., of steel wire and strip, the material is heated by means of passing it through a furnace or high temperature lead bath. The work is heated by means of conduction, and the rate of heat transfer through the material is dependent upon the thermal conductivity of the steel being heated, furnace and lead pot temperatures and other external influences. These factors are more or less fixed; at best they can be varied over only a limited range, and consequently there is only a narrow range of wire speeds which can be used in treatment. Also, in heating the heavier wires or rods, or larger sections of strip, (especially in furnace heating treatments) it is very difficult, and often impossible, to obtain a uniform heating rate through the section, the usual condition being that the surface of the wire attains the desired temperature much faster than the interior of the section, and remains at that temperature for a longer period of time. This, at the solution temperatures, results in an undesirable grain growth near the surface, and a nonuniformity in grain size through the cross section of the material.

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Lead Pot Heating Practices

IN the ordinary furnace or lead pot heating practices, it is not

possible to quench the wire at the instant it has reached the required temperature throughout its cross section, because of the space separating the heating and cooling or quenching zones. As the wire is transferred from the heating furnace to the quench bath, it loses heat from its outer surface, and the temperature is not uniform throughout the section at the instant quenching begins. In the case of furnace heating, there is always the problem of refractories and their maintenance. The high temperatures used, break down these refractories very rapidly, and it becomes necessary to reline the muffles periodically. Where lead pot heating is resorted to, a considerable amount of lead is lost through oxidation, and maintenance costs are high due to the rapid deterioration of the pots.

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IN either case, where furnace, or lead pot heating is used, considerable time is required to heat the furnace or pot to the operating temperature. In general, continuous heat treating practices for wire and strip in which furnaces or lead pots are used for heating the work fail to bring about ideal conditions for the heating and cooling cycles, and the factors affecting these important steps, are very difficult to control.

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Electric Direct Resistance Heat Treating

ELECTRIC Direct Resistance continuous heat treating utilizes a new principle of heating for the continuous patenting, tempering, and annealing of steel wire and strip. The wire or strip is heated to the quenching temperature by means of passing an electric current directly through it, and subsequently quenching it through a definite temperature range, or ranges, depending on the treatment required, and the structure desired in the treated material.

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WITH resistance heating, more accurate control of heating and cooling cycles is possible than is the case with furnace or lead pot heating methods. The electric current is applied directly to the moving strand of wire or strip, and the material attains the correct quenching temperature by virtue of its own electrical resistance.

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THE heating is very uniform throughout the cross section, and a much faster heating rate is possible. In addition, the heating and cooling rates are very flexible, and can easily be adapted to any conditions necessary to obtain the desired results. As an illustration, it is possible to control the quenching temperature of the wire within a range of plus or minus 10° F. by controlling the voltage being applied to the moving wire. The material attains the quenching temperature in a few seconds, since the heating rate is not dependent upon the thermal conductivity of the steel, furnace temperatures, etc., and consequently far greater wire speeds than those used in ordinary procedures are possible.

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QUENCHING is accomplished on a rising temperature, that is, the temperature of the wire is increasing right up to the point where it enters the quench. This permits a much more rapid quenching to the temperature at which the desired transformation is to take place. The wire heating cycle on Trauwood equipment is very efficient, well over 90%; all of the electrical energy applied being used to heat the wire.

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WE will present at the Wire Association meeting a group of lantern slides which will illustrate the various points of difference between continuous electric wire treating equipment and conventional strand treating equipment where furnaces or lead pots are used to heat the work. These illustrations will be as follows:

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Slide #1 — Installation for Patenting and Tempering in a Wire Mill

THE first slide will show a combination patenting and tempering installation in a wire mill. In the foreground are the take up reels on to which the finished wire is drawn. This unit is designed for patenting and tempering sixteen strands of wire simultaneously and will handle a size range of from #5 gauge to #22 gauge.

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A TEMPERING unit such as this can be converted into a patenting unit in about two hours time. This installation can also be used for the annealing of stainless steel, or other austenitic steel wire, since no difficulties are encountered in reaching the high quenching temperatures necessary.

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Slide #2 — Time-temperature Curve for Tempering

THIS curve illustrates the heating and cooling cycles on #10½ gauge .128" dia. spring wire tempered by the Trauwood method. The wire is heated to 1450° F. by means of passing an electric current through it, and at this point it is quenched in a low-melting point alloy bath maintained at about 450° F., and subsequently quenched in an oil bath where the transformation to the fully hardened product takes place. The wire then enters an electrically heated lead bath maintained at about 800° F., where it is drawn back to a hardness of about C-45 Rockwell. On leaving this bath it is cooled to room temperature in a bath which contains a rustproofing oil.

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Slide #3 — "S" Curve Showing Relative Quench Speeds

THIS curve compares the speed of quenching in air, oil, and the "Alloy-oil" quench which is used in the Electric tempering treatment. The fine austenitic grain produced by the uniform and rapid rate of Electric Resistance heating requires a more rapid quench than can be obtained in the conventional oil quench. Quenching into a low melting point alloy bath down to 450° F. and subsequently quenching in oil fixes the fine grain produced by the rapid heating and insures a fully hardened structure. In this quenching arrangement the physical stresses set up in the wire by the rapid quench to 450° F. are relieved be-

fore the martensite precipitation takes place in the oil.

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Slide #4 — Photomicrograph of Electrically Produced Martensite

THE photomicrograph at 2000 diameters magnification illustrates the form of martensite produced by Electric Resistance heating and subsequent quenching in an alloy bath and oil. The structure differs from the conventional form of martensite in that it possesses an extremely fine grain and there is an absence of any acicular, needle like pattern. Although this structure is file hard (about C-65 Rockwell) it is extremely tough.

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Slide #5 — Photograph of Hardened Section Bent

THIS photograph shows the remarkable bending properties of a piece of straight .67% carbon wire which has been electrically hardened. The fully hardened structure produced electrically has greater impact strength than the same wire conventionally treated.

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Slide #6 — Photomicrograph of Electrically Produced Secondary Sorbite

THIS photomicrograph, at 2000 diameters shows the typical structure of wire which has been electrically tempered. This is a straight .67 carbon steel spring wire which has been drawn to a hardness of about C-45 Rockwell. The electrical treatment produces a much finer grain than that obtained in conventional tempering operations, and the treated wire possesses physical properties superior to those of the same wire tempered by the usual methods.

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Slide #7 — Table of Physical Properties of Tempered Wire

THIS table compares the physical properties of carbon steel wire Electrically tempered with those of the same wire conventionally tempered. As can readily be seen, the electrically treated wire possesses considerably higher physical properties than the regular oil tempered wire drawn to the same hardness.

Slide #8 — Photograph of Fracture on Tensile Specimen

THIS photograph shows the unusually large reduction in area of a specimen of electrically tempered spring wire which has been subjected to a tensile test. Note the interlacing, cup type fracture.

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Slide #9 — Fatigue Testing Machine

FATIGUE tests were made to compare the endurance properties of electrically treated wires with the same wire conventionally treated. The machine used for these tests was of the reversed flexure constant strain type as shown on this slide. It is capable of speeds up to 15,000 R. P. M., and is fitted with a vernier attachment for reading the angle of flexure to compute the stress applied to the wire.

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Slide #10 — Curve Showing Fatigue Characteristics

RESULTS of numerous fatigue tests proved conclusively that Electrically tempered and patented wires possessed better endurance qualities than the same wires conventionally treated. The curves shown were determined by running a series of tests at different stresses. The tests were begun with an applied bending stress of over 90,000 lbs. per square inch, and the stress was gradually reduced until the specimens ran 10,000,000 cycles without breaking. The endurance limits of the Electrically treated wires were consistently higher than those of the conventionally treated wires. At an applied stress of 79,000 lbs. per square inch, the oil tempered wire broke in 259,000 cycles while the electrically tempered wire ran indefinitely. It may be noted that the fatigue limit of the electrically tempered wire is about 3000 lbs. per square inch higher than that of the oil tempered wire.

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Slide #11 — Showing Various Springs

ON the average, two or three hundred springs are used in the construction of every automobile. These include coil springs, flat springs, and wire forms. Although the spring may seem to be a small part of the unit on which it is used, yet the operation is absolutely dependent on it. The spring is the life, the controller of the mechanism. Correct heat treatment puts life into the wire to be fabricated into springs and is responsible to a large extent for the service and fatigue life of the spring.

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ELECTRIC Direct Resistance Heat treating apparatus is extremely flexible. A tempering or patenting unit may be used for the annealing of stainless or other austenitic steels.

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Slide #12 — Stainless Annealed Structure

THIS slide at 1000 dia. shows the structure of an 18-8 stainless steel which was annealed electrically. The wire was heated by the direct resistance method to 2100°F. and rapidly quenched to obtain the best physical properties for drawing to smaller sizes. After this treatment it was found possible to accelerate the speed of drawing and also to make larger reductions in drafting.

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AN electric tempering installation can also be used for the patenting of wire. The conversion from tempering to patenting can be made in about two hours time.

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Slide #13 — Relative Heating and Cooling Rates on #5 Rod

THESE curves compare the relative heating and cooling rates of #5 hot rolled rod patented by the regular furnace method and by the electric method. As can be seen from an examination of this curve, a much more rapid heating rate is possible by electric resistance heating than by furnace heating. This rapid rate of heating produces an extremely fine austenitic grain and a good dispersion of the carbides in the patented structure. Another important point in the electric patenting treatment is the fact that there is no soaking period in the heating cycle. As soon as the wire attains the quenching temperature, it enters

the lead or salt quench. The soaking period is not necessary in resistance heating because the rapidity and uniformity of the heating accelerates the changes of solution and carbon diffusion at the maximum quenching temperature. In the patenting of wire by this method, a finely dispersed sorbitic structure can be produced without the use of temperatures as high as those used in conventional methods. Any temperature desired can be attained quickly and easily and any temperature changes necessary during operation can be affected very rapidly. Wire patented by the electric method has an ideal structure for the subsequent operation of drawing.

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Slide #14 — Electrically Patented Structure

THIS photomicrograph at 2000 diameters shows the structure of spring wire which has been patented electrically. The wire was heated by electric resistance to 1500° F. and quenched on a rising temperature into a lead bath maintained at about 975° F. Note the uniform dispersion of the carbides throughout the structure.

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Slide #15 — Double Lead Patented Structure

THIS microphotograph also at 2000 diameters magnification shows the structure of the same wire conventionally double lead patented.

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Slide #16 — Furnace Patented Structure

THE photomicrograph shown here at 2000 dia. is a sample of spring wire conventionally patented by furnace heating and salt quenching. As can readily be seen, the structure is a good deal coarser than that of the electrically treated wire.

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THERE is a considerable difference between the physical properties of wire electrically patented and the same wire conventionally patented.

Slide #17 — Physical Properties Of Patented Wires

FROM this table it is very evident that the electrically patented wire possesses superior physical properties. An interesting point in this connection is the fact that although the electrically treated wire is somewhat harder, it is more ductile, from the standpoint of its reaction to cold flow in drafting.

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THE ductility desired in the patented state is not in the sense of ease in drawing but rather the greatest capacity for uniform cold flow.

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WIRE drawn from electrically patented stock has a short fiber as compared to the wire drawn from conventionally treated stock.

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Slide #18 — Electrically Patented And Drawn Wire

THIS photomicrograph at 2000 diameters is typical of electrically patented and drawn structures. This particular wire was drawn from a #13 Gauge electrically patented wire to #27 Gauge. This represents about a 97% Reduction in drawing.

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WIRE drawn from electrically treated stock possesses considerably higher physical and fatigue values than those of conventionally patented and drawn wires.

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Slide #19 — Curve Showing Effect of Drawing on Phys. Prop.

THE curves shown here compare the effect of drawing on the tensile strength and the elongation in a given reduction can be obtained from the electrically patented wire. In practical application this means that one or two holes in drawing can be eliminated to obtain a desired tensile in a given reduction.

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REVERSED flexure fatigue tests made on wires drawn from stock patented by the two different methods disclosed the fact that the short fibered wire drawn from electrically patented stock possessed considerably better endurance properties.

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Slide #10 — Slide of Fatigue Curves

NOT only was its endurance at stresses above its fatigue limit better than that of the conventionally treated and drawn wire, but its fatigue limit was considerably higher than that of the wire conventionally treated and drawn.

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Slide #20 — Table of Fatigue Values

THIS table shows the relative endurance properties of wires drawn from electrically patented stock and conventionally furnace patented stock.

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IN general, on the strength of numerous physical and fatigue tests made on wires drawn from electrically patented stock, it may be said that the range of limits of physical and fatigue values is narrower in the case of the electrically treated material when compared to wires given identical drawing treatment from conventionally patented stock.

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Slide #21 — Surface Decarburization of Conventionally Patented Wire

A NOT altogether unimportant feature of the electrical treatment is the fact that there is no surface decarburization, and, although no special atmospheres are used in the heating cycle, there is practically no scale as compared to conventionally treated wires.

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THE slide shown here illustrates the surface decarburization usually found in furnace heated conventionally treated wires. During the necessary soaking period in the heating cycle, in the case of furnace heating, the carbon content of the surface of the wire is depleted through oxidation. The resulting product has a lower carbon exterior as shown.

Slide #22 — Surface Condition Of Conventionally Patented Wire

THIS slide illustrates the surface condition of conventionally patented wires. The oxide scale as you will notice has a patch appearance, some of the scale having fallen off before the wire reached the take ups.

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Slide #23 — Surface Condition Of Electrically Patented Wire

THIS slide illustrates the surface condition of electrically patented wires. Because of the rapid heating rate, and the short period of time the wire is at the scaling temperature, only a light continuous oxide film is present on the surface of the wire. Only about ⅔ of the pickling time given to conventionally treated wire is necessary to remove the film on electrically patented wire. After pickling and drawing, the electrically treated wire has superior surface qualities.

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General Information

ELECTRIC Direct Resistance continuous patenting, tempering and annealing equipment is fully automatic in its operation. Once a unit is started on production, it requires no attention other than loading the payoff reels and taking care of the wire on the take ups.

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AN electric wire treating installation can be brought up to working temperature in about 1½ to 2 hours time from cold, after which time production can begin. The temperature of the wire can be raised or lowered quickly and accurately, and any temperature changes which might be necessary during operation can be affected very rapidly.

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THE cost of treatment by the Electric Direct Resistance method is relatively low. The power to heat the wire to the quenching temperature is between 170 to 175 K. W. H. per ton of wire treated. As mentioned before, the thermal efficiency of the heating cycle is high, over 90%, all of the electrical power applied being used to heat the wire; there being slight radiation and other losses. Maintenance costs on the equipment are low in comparison to furnace and lead heating. The maintenance costs on furnaces and high temperature lead pots amount to a considerable figure.

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THE operating labor costs on electric wire treating equipment are relatively low. One man can operate a tempering installation, taking care of the pay off reels and the take up reels. The operation of an electric wire treating unit is essentially a wire handling proposition. Further advantages of this method of treatment, most of which are obviously apparent may be summarized as follows:

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1. A product with higher and more uniform physical and fatigue properties, and greater impact strength is obtained.

2. There is no surface decarburization and there is practically no scale, even on wire run without the use of special atmospheres. The treated wire has an excellent surface condition.

3. Much finer grained structures are produced than possible by conventional methods of treatment.

4. Much greater wire speeds than those used in conventional practices are possible.

5. The heating and cooling cycles can be controlled very accurately.

6. The wire is quenched on a rising temperature, and exactly at the temperature required instead of on a temperature which is falling as in the usual methods.

7. A wire tempering unit can be converted into a patenting or annealing unit in a few hours time.

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✦ ✦ ✦

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The Endurance Properties of Hard Drawn Wire From Various Kinds of Copper

By John N. Kenyon,
Instructor In Civil Engineering,
Columbia University, New York, N. Y.

This paper describes a method for making endurance tests on copper whereby some 20 inches of hard drawn wire is subjected to equal stress - reversals. The effects of crystalline inhomogeneity and surface imperfection over a considerable length of wire are thus integrated. Several months will be required to complete the study but the trend of the fatigue curves indicate that certain "oxygen-free" and vertical cast (V.C.) tough pitch coppers have the higher endurance values. ✦ ✦ Preliminary tests are being made whereby the copper wire specimens are exposed to weak solutions such as may be encountered under service conditions. These corrosion-fatigue tests give promise of interesting results. ✦ ✦ ✦ ✦ ✦ ✦

NEARLY one century ago the first experimental laboratory was founded to determine why a peculiar straight-across break occured in steel railroad axles. For lack of a better term these failures were termed fatigue breaks. Today extensive investigations are still being carried out on steel with no abatement in the possibility of obtaining more important information. Compared to steel, copper is a virgin field wherein comparatively few fatigue studies have been undertaken. This lag is largely due to the fact that copper has been extensively used only within recent times; it has come about with the large development in the electrical industry. Fatigue studies on copper have also been handicapped by the large amount of time required. To establish a fatigue curve for copper, it takes at least 20 times longer than it does for steel.

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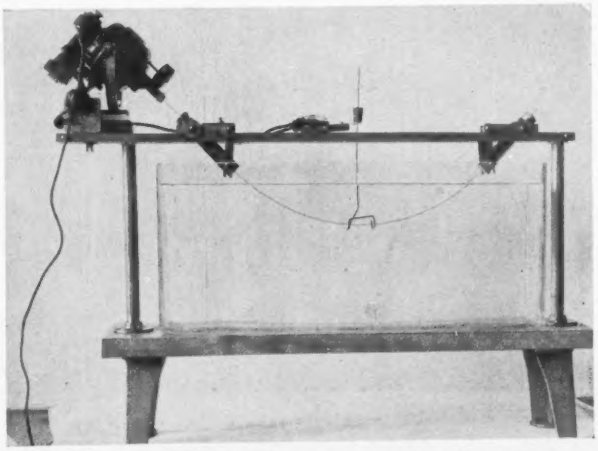
SOME fatigue tests have been carried out on hard drawn copper wherein machined and polished test specimens were used. These data give indication of crystalline homogeneity but not of any effect due to surface irregularity. Hard drawn copper wire is a fabricated finished product with the usual run of surface imperfections; it should be tested in this processed condition. Since 1930, several wire fatigue machines have been developed functioning on a principle whereby the greatest stress, exerted on the test specimen, occurs at the center of length. Fatigue breaks are necessarily confined to this point regardless of imperfections elsewhere. The most desirable test on wire is one which subjects the material to equal stress variations over a considerable length.

✦ ✦ ✦

THE Rotating-Wire Arc Fatigue Machine, described before the **American Society for Testing Materials** in 1935,[1] is being used for the endurance tests on copper wire. Essentially this method consists in bending a straight length of wire to a curve by means of two inclined bearing metal guides and rotating this wire from one end by a motor. The other end of the wire is left free to slide longitudinally in its guide and, in so doing, this test specimen **automatically** assumes the curvature of the circular arc. Some 20 inches of wire are thus subjected to equal stress-reversals with fatigue failure occuring at the weakest point within this length. The rotating arc dips into an oil bath which dampens out vibrational effects. This dampening method offers an unique advantage for making corrosion-fatigue tests wherein the oil is replaced by aqueous solutions. (See photograph)

Mr. Kenyon is Instructor in Civil Engineering, Columbia University and holds the degrees of A.B. from Syracuse University and B.S., Met.E. and Ph.D. from Columbia University. In 1916 he had charge of inspection of munition steel with the British War Mission. In 1918 he entered the employ of the Carnegie Steel Company in the manufacture of electric-furnace steel. In 1923 he was employed by Columbia University as testing engineer and has been appointed instructor in civil engineering. Mr. Kenyon is a member of the British Institute of Metals, the American Society for Testing Materials and the Electrochemical Society. He is a licensed professional engineer in New York State. He is the author of several technical treatises published by the American Society for Testing Materials.



Rotating-Wire Arc Fatigue Machine. (Author's Design) Note: Exposure of 15 secs. with machine operating at 6,000 R.P.M. ✦ ✦

(1) J. N. Kenyon, "A Rotating-Wire Arc Fatigue Machine for Testing Small Diameter Wire", Proceedings, Am. Soc. Testing Mats. Vol. 35, Part II, p. 156 (1935).

(*Please turn to Page 632*)

5 convincing FIRTHALOY

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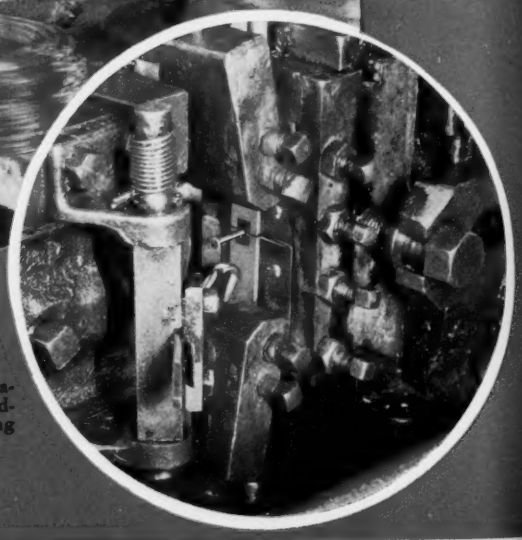

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3

LOWER POWER COSTS—

Nail machines equipped with Firthaloy Heading, gripping and cutting Dies operate under a relieved load, due to ease of pinch, resulting in reduced power consumption.

4

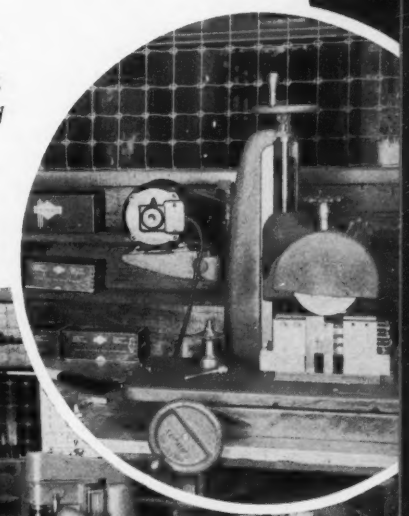
MAXIMUM QUALITY—MINIMUM SCRAP—

Firthaloy's nearly diamond-hard qualities give continuous on-size production of such accuracy that highest quality is maintained, reducing scrap to a negligible minimum.

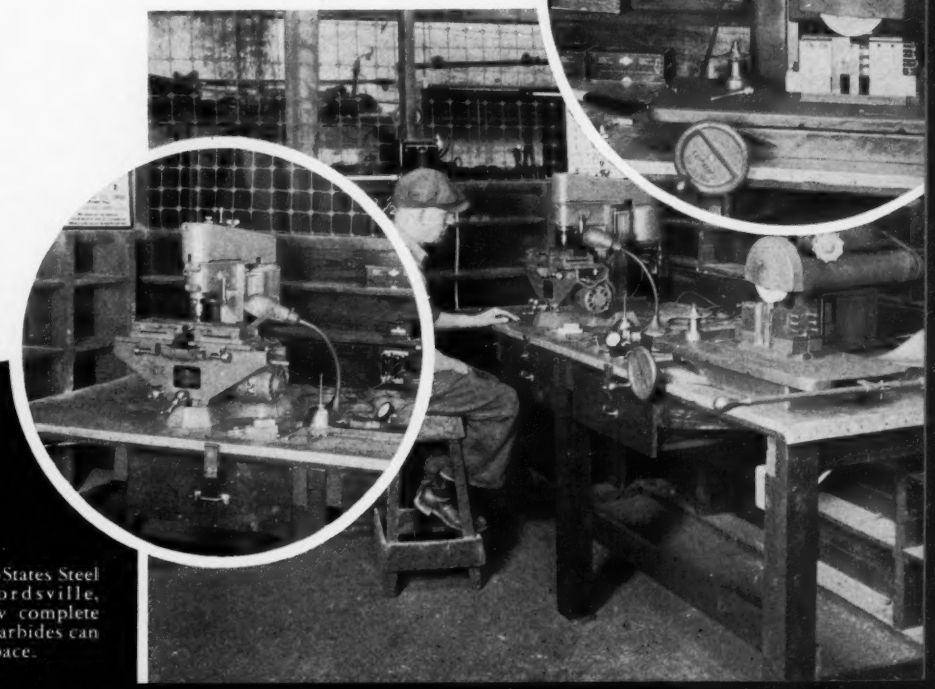
5

LESS MACHINE MAINTENANCE—

Smoother operation of Firthaloy equipped nail machines, less jamming, fewer shut-downs, definitely lowers maintenance costs.



Carbide grinding equipment available from Firth-Sterling at modest cost.



A Carbide Barbing and Lapping Machine designed by Firth-Sterling and available at reasonable cost.

Nail Die Room at Mid-States Steel & Wire Co., Crawfordsville, Indiana, showing how complete facilities for working carbides can be installed in small space.

To What Extent Can Market Research Be Applied To Industry?

By Pauline Arnold,
Vice President,
Market Research Corporation of America

WHEN I started to think about this talk, my first idea was to transcend our own personal experience with the application of research techniques to the industrial field, and to find out what industrial firms themselves do with market research. So I wrote to some of them, and as a result I have letters from about forty telling me their practices and their attitudes. Most of these are big companies: manufacturers of steel, electrical goods, copper, refractories, machine tools, leather beltings, dies, piston rings — companies which are, without question, in the industrial field. These forty letters, although a small sample, are a good cross section of industrial firms, ranging from medium sized companies to some of the largest in the world and manufacturing widely diversified types of products.

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VERY full and interesting material about market research came to me in these letters. It is obviously a subject of very real interest. But this interest is not uniformly distributed among all companies. As I studied the letters, I found a sharp division between almost equally balanced numbers of firms: certain companies obviously have a clear conception of the use and the value of market research in their business; the others seemed to have no very clear idea of what market research is, and certainly no conception of its having any value to them.

Primary purpose of the specific market study is to outline the market for new products or study a market for a product that might be designed to fit the need. Commercial research should be aimed to bring out underlying facts and controlling causes rather than mere surface facts and resultant effects. ✦ ✦ ✦ ✦ ✦

NO common denominator was apparent for either of these groups; that is, those companies which find market research useful are not all characterized by one kind of problem, nor those which do not use it, by another kind of problem. Indeed, whether or not they find market research of value appears to rest almost entirely on how intelligently and imaginatively they have adapted it to their own needs.

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IN considering what these companies mean when they speak of market research, we must differentiate between two aspects of it, which, in the industrial plant at least, are certainly both important, although they have entirely different functions. We might distinguish these by calling them internal and external research respectively.

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INTERNAL marketing studies depend upon two main sources: first, the company's own records, and second, all sorts of bibliographical data. Such studies would have to do with market trends, economic factors, sales analyses, sales territories, data for the setting up of potentials and sales quotas, etc. Such work is largely statistical, must or should be carried on regularly and continuously and is properly, in most instances we believe, the function of a regular research branch of the marketing department. A great many of the companies carry on such work, though not always under the name of research.

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EXTERNAL market research, on the other hand, depends upon the unearthing of other first-hand facts beyond the company records. It is the type of market study where the answer lies outside the walls of the plant and outside of available collections of information; where some special problem or situation must be studied and solved, or material provided for the guidance of constructive action. Such a problem may take a month's study or a year's, it may be set up as an emergency operation or as a continuing repetitive process; but its kernel is the necessity to assemble and study new materials outside the plant's own walls. Some few industrial companies are set up to handle such work, or they associate with outside organizations which provide the experience and the facilities; the majority appear to do little or none of this type of research, and a very large number have no familiarity with any such specialized process, and apparently no knowledge of the way in which it might be of value to them.

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THAT half of the companies which had no clear idea of the value of market research may be

An address delivered before the National Industrial Advertisers Association in Toledo, Ohio.

be installed in small space.

said to do no work which they classify as market research. In some cases, for instance, they display a real misconception of it, implying that it is of use only for goods sold to the general public. For example, one letter is fairly typical which says: "We sell nothing to the general public in usable form and therefore work of this particular research nature is of no very great use to us." Of course, this idea that market research is of use only in studying goods sold directly to the consumer is a misunderstanding of the entire theory, since every company has its market, no matter who or where the customers may be.

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MANY other firms in this group consider that their markets are so limited that they know all they need to know about them. To be sure, there are cases where this is undoubtedly true, but I doubt if they are as numerous as the manufacturers believe. Some letters are rather scornful of research as an academic proceeding and imply that it is not sufficiently "hard boiled" and practical for industrial firms.

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ANOTHER conception which this group entertains to a considerable extent is that their sales or product development departments constitute a marketing research department, since these departments are concerned with the SELLING of goods. It is not obvious to them that a marketing research department is one which develops data on which to base policies which a sales department carries out.

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ONE company says, for instance: "We maintain our own sales offices in all parts of the country, and believe through these offices we are able to keep ourselves quite well informed as to all conditions affecting our business."

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WE believe there is a fundamental difference between the scientific, impartial and objective collection, analysis and interpretation of materials bearing on sales conditions; and the subjective, sometimes defensive, miscellaneously collected personal impressions (which must be subordinated to real sales activities), are often the best that can be given by a sales department. Each type of approach has its place and its value, but they are not the same thing. Certainly any sales manager wishes to get all possible information from district sales managers, salesmen, etc., on all questions relating to the market for the product; but we consider it extremely difficult, if not impossible, to get sufficiently well-balanced general marketing material in this way, the interpretation of which can be properly evaluated.

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ONE company wrote an interesting letter on this point. Their numerous district sales offices are required to report on business in their territories which has been lost. These data are then related to total sales of that product in that area. The company has invariably found that only about 60% of the total volume can be accounted for by the company's own sales and those reported as having been lost. They have ascertained that at least 20% of the unaccounted for 40% were known losses which have not been reported by the company's own salesmen, who could not, or would not, give complete reports. It is certainly natural not to be able to be entirely objective in evaluating one's own work.

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THE other half of our sample companies appears to have a much better conception of market research and in the main to regard it as an important part of their operations. A considerable number of these maintain their own specialized departments, although several of them do only what we have called internal work. The remainder, also an important number, look upon both their internal and external market research work as an integral part of their operations, and they report on it in detail and with much enthusiasm.

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ONE company says: "We feel that the value of market research for a business like ours is in the category of a requirement in the consideration of new products and as a guide for trends and changes in existing operations, and usages of our products."

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ANOTHER evaluates their department of ten men as follows: "Although we can't set the value of market research to us accurately in dollars, market research makes an essential contribution in helping to solve marketing problems. Perhaps the best indication of its value is that the Market Research group was organized early in 1932, near the bottom of the depression, and has been active continuously since then. Without the aid of a market research group I am sure needed facts might not be collected, partly because the sales organization does not have the time, the necessary contacts, and the training in framing and asking questions."

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A COMPANY which is in the packaging field says: "The value of market research in any company depends on the extent to which the information is put to practical use. In our company the facts developed are used in sales portfolios, slide films, sales literature, advertising, etc. The measure of its success is also greatly dependent on the extent to which the sales department is convinced of its usefulness. In our own company the research jobs now being done are almost entirely on request from the sales department and are continually increasing."

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ANOTHER company quotes at great length the type of marketing studies which it has carried on and says: "Market research is not only extremely valuable, but an economic necessity in our business. Moreover, its importance is increasing with the intensification of competition, the narrowing profit margin of our industry, and with the introduction of more specialty products."

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A NUMBER of these firms maintain their own department, devoting themselves entirely to such work. The size of these de-

partments ranges from 1 to 15 men but are in almost all cases supplemented by men from the accounting, stenographic, engineering, etc. departments, and of course, by professional marketing organizations as desired.

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THERE are then, two groups of these manufacturers: those whose use of market research is at least appreciative and those who fail to recognize or understand it. The extensive work done in the consumer field has not been carried over into application to the industrial field to the extent that it might well have been. This is particularly true in what I have termed external research, the use of which has definitely been limited in this field.

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THIS is partly because the fastest development and the most spectacular and publicized results of market research have been in the consumer field. Norge can advertise in all national magazines, that 20,000 women helped them design their new refrigerator; but the Cincinnati Milling Machine Company, on the other hand, can create no great excitement over the fact that their customers helped write the specifications for a new milling machine.

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SO—the question arises, what is there that the practice of market research as developed in the consumer field can do in the industrial field? This, by definition, applies more to the external form of research than to the internal.

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IN a speech last summer, **C. H. H. Weikel,** manager of the Commercial Research of the **Bethlehem Steel Company,** gave an answer to this question. He said, "General market surveys are ordinarily designed to determine continuously the geographical demand for standard products. Special market surveys are made as required and include surveys of plants or industries for the purpose of determining:

(1) The extent of use in such plant or industry of standard of specialty products of Bethlehem manufacture, and

(2) The possibility of extending the use of steel in such plant or industry by modification of an old product or in the development of a new product."

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THIS introduces one of the primary purposes of specific market studies: The analysis of a market for a new product, or the study of a market for a product that may be designed to fit the need. We undertook such a study as this for a client a year ago when his plant had produced a special coating for a certain metal that permitted uses never before practicable. There were many fields in which its use might have been practical, but none which had been predetermined. Moreover, there was no indication of the fields in which immediate promotion might be most effective. In this project it was not necessary to have engineers fully familiar with the product to discuss the possibilities with potential customers. With a sample and a description, interviewers with general training talked with specifying engineers in such industries as had been first selected. In some industries the product had little appeal or other products were doing the job equally well. But in a few of those original contacts (only a small portion of the ultimate potential market) the possibilities of the product were so quickly realized that interviewers almost became order takers. This study saved months of valuable sales time through directing promotion and sales into the proper channels.

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ANOTHER problem suitable for study through research methods is the sort of case in which the customer, although an industry, is actually a consumer. Here the situation is nearly identical with that of any consumer goods. The customer is buying for use in his own plant, not for fabrication or for embodiment in another product. In this case it sometimes becomes necessary to carry out almost exactly the same kind of a study which would be made with any consumer product. The industrial division of one of the large oil companies conducted such a study some time ago when interviewers contacted a large proportion of the factories which were potential users of oil and grease. This was a problem of studying competition, why sales were not being made, what was wrong with that particular product, what specification would make the product more useful to the particular needs of the customer, analysis of complaints in service, delivery, performance, etc., the same techniques that have done well in ten thousand consumer goods studies.

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STUDIES of this nature may be best handled in such a way that there is no direct identification of the interview with the particular product being studied. No buyer will speak freely if he knows that he is talking to the representative of some special company. As a result of this oil survey, the company obtained a better knowledge of how to standardize certain of their products to fill greater needs, how to rectify conditions that had been causing dissatisfaction, and what was the exact nature of a highly specialized demand.

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IN many other cases it becomes necessary to study the end product, the form in which the goods will finally reach the consumer, in order to help the fabricator or user to sell more and thus use more. The glass company sells bottles and the can company sells cans, not to the consumer but to the brewer, yet market surveys have been an active part of their program especially in the beer and milk fields. They have to study consumer demand in order to know better how to sell their product to these industries and to enable the brewer and the milk companies to make the best use of their product. Packaging machinery manufacturers are in exactly the same position and have the same need of research techniques.

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EVEN in fields remote from what we call the ultimate consumer, the real consumer of the end product may hold the key to sales. The manufacturer of lithographic presses does not stop with the building of a press to order. He finds out what kinds of presses he

ought to be building, he attempts to standardize presses where possible, by studying the end results of lithography. It is he who can profit by knowing new uses to which lithography is being put, studying the kind of results the advertiser wishes to get in his booklet, the direct color photography he wants to employ. Having located the potential demands of the ultimate market for his product, he proceeds to build machines which will create these demands. It is a good way to sell lithographic equipment profitably.

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MANUFACTURERS of electrical wiring have made intensive studies of home building, as related to homes of varying values and their wiring requirements. These studies required direct interviews with householders to obtain materials permitting evaluation of potentials for the different kinds of wiring. These could then be related to available building statistics in order to measure the requirements of the market. The study also yielded important results on the general under-capacity of wiring in relation to the number of home appliances, the ownership of which was studied at the same time. It thus provided data on which to build rewiring promotion, keyed to the increase in appliances.

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IN the field of service and satisfaction with products, market research fits industry as well as the consumer. No manufacturer is going to fail to see the value of an objective analysis of his customer's reaction to his products. Too often such information is obtained only from reports of the salesman or district manager. In all probability, if a man is a good salesman, he is not a good interviewer.

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TO many industries market research can give invaluable aid in guiding sales techniques. To continue the illustrations of its usefulness, it can answer such questions as: To whom does one sell in the different customer companies or in the different fields? To what extent is the influence of the purchasing agent vital, or where and with what products is it essential to reach the vice-president in charge of production? Where does the entire management enter into the picture, or where is it an engineering problem decided solely by specifications of the engineering staff? These features of selling policy can be predetermined for most companies. This, too, is a marketing problem.

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CLOSELY connected with this is the problem of whom you should try to reach with your advertising, what the sales story should be and what media will carry the greatest weight. This is certainly a typical research problem. Studies in the media field, including the person to reach with decisions, are commonplace with consumer goods and equally adapted and perhaps even more important with industrial products. You can afford to miss sometimes with a fifteen cent item; but you cannot risk a wrong approach to the wrong man when thousands of dollar orders are at stake. The advertising field is one of the home grounds of market research.

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MR. WEIKEL, from whom I quoted above, seems to me to have made some very good

You'll draw more wire tonnage per die, and have fewer mill interruptions when Teco Carbide Dies do the wire drawing job. You'll find, too, that Teco Dies last longer, which means lower die costs in the long run. Secret of these cost-cutting advantages is TECO METAL'S unique carbide composition. As progressive machine tool operators know, Teco combines a close approach to diamond-hardness with tremendous toughness.

Hard, tough TECO METAL is slow to wear, and wears evenly. More wire can be drawn before redressing is necessary. And it's smoother wire! TECO METAL'S composition, lending itself to an extremely high polish, gives drawn wire an unusually fine finish. Fewer delays for die changing and refinishing keeps machines running longer without interruption, stepping up plant output all down the line. Whatever you ask—increased production, lower drawing costs, finer finished wire, longer lasting dies—you get it when you specify Teco Carbide Dies.

A Tungsten Electric engineer will be glad to discuss your wire drawing problems with you. Consult us today. Get the complete, cost-cutting story of Teco Dies.

Never Say Die—always specify
TECO CARBIDE DIES
***for smooth* wire drawing--they last longer!**

Tungsten Electric supplies carbide blanks, tools and bits. Wire and bar dies, tubing, extruding and sizing dies. Also, special tools, such as spot facers, reamers, broaches, form tools, etc.

TECO
MORE THAN A DECADE OF CARBIDE EXPERIENCE
TUNGSTEN ELECTRIC CORPORATION
564 – 39th ST. • UNION CITY, N. J.

points when he said: "The objective of commercial research . . . should be to study markets . . . and influences controlling such markets, and to make recommendations based on such studies which will enable the executives to determine rationally rather than speculatively the following:

(a) The soundness and efficiency of major company policies relating to the manufacture, distribution and sale of such commodities, and the proper direction of changes in such policies.

(b) Efficiency of methods of distribution and efficiency of sales offices and individuals, and ways and means for increasing efficiency.

(c) Modification of, expansion of, or addition to manufacturing equipment and products."

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HE then says, and this I think is the nub of the matter, "In order to realize the foregoing objectives, Commercial Research should aim . . . to bring out underlying facts and controlling causes rather than mere surface facts and resultant effects." This, I think, in a nutshell, is the difference between true market research properly applied and non-professional efforts to find out what is wrong with a business or what should be developed in a business. Market research implies a scientific, laboratory approach to date, an analysis of these "underlying facts and controlling causes" in contradistinction to "mere surface facts and resultant causes."

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PARTICULARLY in studying situations relating to the first two of the above points, the efficiency of major company policies and that of sales offices and individuals, it is essential that a more objective approach be made to the situation than is possible in relying on salesmen's reports, no matter how carefully they may be made. At the same time, it is perfectly possible for the marketing department or for an outside research organization to gain an understanding of the relation between the producer and the purchaser that may well improve major policies. Such an approach also produces a balanced picture, because it correctly samples all the elements involved, instead of tending to lay undue emphasis on points which seem to stand out in personal experience but which are not necessarily typical of a large group of customers.

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IN producer-customer relations, above all, the impartial, objective viewpoint is essential and it requires scientific judgment and training to be sure that one is obtaining "underlying facts and controlling causes rather than surface facts and resultant effects." Incidentally, such an approach is already continually used to study producer-customer relations by manufacturers of consumers' goods who sell through jobbers and dealers. Such problems are by no means unique in the industrial field.

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THIS list of situations where it is vital could go on for the rest of the evening. The quickest way to outline more of the various problems for which some companies are using market research is to read a few more extracts from letters, since there is great diversity in the studies undertaken by companies actively using external research methods. You can probably all find parallel needs in your own experience.

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ONE company, which has been actively engaged in market research for a year and a half, reports: "Briefly, we have been attempting to add products to our line and define more closely the market for some of our better established products. This job has been particularly important because of the slowly declining trend of our main product. We also have found market research to be useful in the reallocation of some sales territories. The point of departure in this work was the defining of mill supply trading areas and market potentials. "Of course, I try and make use of market research information in our promotional work. We have made some consumer surveys which have given us a basis for not only reconsidering our line of products, but what appeals and sales points should be used in our advertising and actual selling. In other words, it has been the basis for much positive direction of our sales force."

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ANOTHER company are confronted by what they consider the "usual problems", which they list as follows: "Identification of customers as prospects, the potential market, the type of instruments required, our standing in the field, customer preference in business practices, frequency of trade contacts."

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A SERIES of problems met by the Market Research Department of another firm is:

"a. Analysis of the company's sales policies.

b. Trend of demand for the type of machinery we manufacture.

c. Our competitive position in the industry.

d. Study of realized and potential markets for our equipment.

e. Search for new products to supply changing needs in markets where we are already established.

f. Study of the machinery needs of expanding industries other than those we are now cultivating."

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A COMPANY, which has made one set of market analysis studies covering the distribution, merchandising, usage, operating cost, buying power, etc., of gas water heating, also describes a second group of studies as pertaining "to requirements for replacement parts and service which include distribution, re-distribution, location of equipment engines, etc., requiring service and other similar data for handling the follow-up of original equipment of products, into the field for servicing and replacement."

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ANOTHER letter states that that company's market research has been concerned with "studying the trends of any particular industry to determine whether they are on the up or down grade. We have also studied the marketing methods of various customer industries in order to tie in our advertising and promotion efforts most effectively, and have at times made merchandising suggestions."

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MARKET research methods have been applied by one

company to the following types of problems:

"Analysis of available business by territories to determine total sales potentialities of each territory.

"Surveys of possible uses for specialty grades and service conditions encountered in specific markets as a guide to proper apportioning of advertising expenditures and proper direction of effort.

"Study of location of major accounts with respect to freight absorption necessitated by increased number of freight basing points.

"Study of possible growth of new types of competitive materials to anticipate their probable effect upon markets for our materials.

"Study of established markets for other types of materials with a view to influencing their replacement by materials of type we produce.

"Market analyses to determine most practicable location for added production facilities.

"Market studies for fabricating customers to assist them in launching new products made of our raw material."

THE Director of the Market Research Division of one large plant says that market research methods have been used in helping to determine:

"a. Possibilities and limitations of undeveloped markets for present products.
b. Potential markets for new or proposed products.
c. Analysis of possible customers by sales districts—number, purchases, preferences, etc.
d. Comparisons between districts of available business vs. orders.
e. Reports on possible uses of products and their relation to other products.
f. Selection of advertising media and sales appeals."

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MANY of the techniques required in consumer goods studies, the mass motivation analyses, the techniques of proper sampling of large numbers, the psychological approaches which are so important in studying the masses, may have no particular place in the industrial field. Some types of problems in this field undoubtedly do require highly specialized engineering knowledge.

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THE problems are different from those of the consumer field—at least to some extent. The sales methods differ widely. But laboratory methods, scientific approach, objective impartiality, a controlled and directed curiosity as to what makes the wheels go round, are the same in every business. When one understands the use of market research, its principles can be applied in lines as diversified as face creams and copper tubing. This technique is what good market research has to offer any business, regardless of the field. It is already more than justifying its existence in your own industries.

Moslo Feeder

JUST released to the trade, a Welding Rod Hopper Feeding Machine is announced by **Moslo Machinery, Inc.** of Cleveland, Ohio. Originally built for one of the larger welding rod manufacturers, the design of this machine proved so successful that it is now being built for general sale.

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PRIME purpose of the feeder is to pass straightened and cut wires or rods into an extrusion press for application of coating material to welding rods. Until now the problem of uninterrupted flow of rods into the extrusion presses has always been a serious one. The Moslo Hopper Rod Feeding Machine is reported to offer an adequate answer.

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UNIQUE in many ways, Moslo builds the hopper entirely of steel plates. Unusually sturdy construction has been used throughout the machine. Capacity of about 500 pounds of wire rods means that little operator attention is required. Guide plates of feeding mechanism are arranged so that adjustment is obtained from a single hand screw with positive adjustment assured, thus it becomes possible to feed from the smallest to the largest diameter rods without fear of interrupted flow because of misalignment.

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SPEED is controlled through an adjustable Reeves drive, permitting absolute matching of feeding speed with whatever extrusion press the feeder may be teamed.

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UNUSUAL, too, is the placement of feeder rolls in a vertical plane while support shafts are in a horizontal plane, making accessibility much greater. Pickup rolls have a single hand screw adjustment so that movement in or out is simultaneous. Feed pressure is maintained through a heavy duty spring, irregularities in wire stock can not jam this feeder. Feeding mechanism is positive and accurate. Adjustment is provided on opposing feed rolls so that perfect alignment of wire with guide tubes is always maintained. This adjustment also permits full compensation for wear of rollers, much longer life being obtained from rolls because of it.

POWER drive mechanism is totally enclosed, running in oil on Timken Roller Bearings. Hardened alloy steel gears assure long, trouble-free service. Ample oversize gears and bearings eliminate any possibility of failure in the drive unit.

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THIS new feeder is supplied at present in three sizes of hopper to take wire in 18", 24" or 36" lengths. Each machine is capable of handling any length up to its maximum. Right or left-hand operation is at the option of the purchaser and feeding height is matched to the extrusion press.

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THUS progress is made in the welding rod industry. Today's new demands for quicker, surer methods are met. Moslo Machinery Incorporated, 5005 Euclid Avenue, Cleveland, Ohio, will be glad to answer any inquiry about this welding rod hopper feeder. A machine will be in operation in Cleveland during the Wire Association General Meeting, October 21-25 and arrangements can be made with Moslo Machinery to see the unit at work.

Make Your Plans Now To Attend
THE WIRE ASSOCIATION ANNUAL CONVENTION
THE NATIONAL METAL CONGRESS

Exports and Imports of Wire

Exports of Iron and Steel Wire Products in July 1940 and July 1939
(In gross tons)

	JULY 1940	JUNE 1940	JULY 1939
Wire rods	21,162	28,036	3,706
Strip steel	17,992	14,488	4,875
Plain, black or galvanized iron or steel wire	13,457	13,608	4,044
Barbed wire and woven wire fencing	3,859	3,966	4,791
Woven wire screen cloth	227	228	125
Wire rope	1,012	683	319
Insulated iron or steel wire and cable—see analysis below			
Other wire manufactures	1,486	1,034	573
Wire nails	5,524	5,707	1,890
Tacks	112	45	18
Other nails, including staples	687	605	434
Bolts, machine screws, nuts, rivets and washers	2,192	1,675	630
Total, these 11 classifications	67,710	70,075	21,405

Imports of Iron and Steel Wire Into the United States
(In gross tons)

Concrete reinforcement bars	.....	1	20
Hollow bar and drill steel	27	32	206
Wire rods	18	78	727
Barbed wire	42	.....	1,612
Round iron and steel wire	20	18	97
Telephone and telegraph wire	.....	.....	.....
Flat wire and strip steel	256	101	238
Wire rope and strand	41	56	141
Other wire	.....	.....	82
Hoops and bands	.....	.....	1,556
Nails, tacks and staples	1	8	838
Bolts, nuts and rivets	3	3	3
Total, these 12 classifications	408	297	5,521

Exports of Insulated Wire and Cable, July, 1940

	Foreign		To U. S. Possessions	
	Pounds	Dollars	Pounds	Dollars
Rubber covered wire	3,789,564	1,034,505	210,222	41,750
Weatherproof wire	116,105	20,341	24,563	4,127
Other insulated copper wire	1,315,258	320,709	263,275	43,988
Nickel-chrome electric resistance wire	39,152	38,066	.....	.....
Total, these 4 classifications	5,260,079	1,413,621	498,060	89,835

Iron and Steel Exports Continue To Mount in July; Import Trade Registers Further Decline

REGISTERING its third marked increase in as many months exports of iron and steel (scrap excepted) from the United States set a new high when, in July, the trade totaled 707,809 gross tons valued at $39,511,996. June exports had amounted to 617,678 tons valued at $38,794,157, while those of July 1939—163,598 tons valued at $12,141,748 — were only one-fourth as great in quantity and a third as valuable as those of July 1940.

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COMPARED with steel ingot production accomplished during the month July exports represented 14.2 percent of the domestic output. In June this proportion had been 12.5 percent whereas in July 1939 only 5.1 percent of production moved in export trade.

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OVER the first seven months of 1940 a total of 3,478,423 tons of iron and steel valued at $237,482,208 has been exported—more than three times as much in quantity and nearly three times as much in value as had been shipped to these same markets in the comparable period of 1939—1,086,873 tons valued at $82,396,045.

✦ ✦ ✦

Import Trade Lower

IMPORTS of iron and steel products (scrap excepted) registered another sharp decline in July when only 3,390 gross tons of these materials valued at $351,826 entered the United States. June receipts had totaled 5,504 tons valued at $530,343, while in July 1939 the trade in these goods had amounted to 27,516 tons valued at $1,285,390.

✦ ✦ ✦

OVER the first seven months of 1940 imports of iron and steel totaled only 42,178 tons valued at $4,851,403—22 percent by quantity and 43 percent by value of the 189,707-ton, $11,311,696 trade of the comparable period of 1939.

✦ ✦ ✦

Scrap Exports in Slight Gain

EXPORTS of scrap — 327,129 gross tons valued at $5,459,356 —were slightly higher in July than in June, when the trade had amounted to 318,369 tons valued at $5,261,321, but fell short of the 350,066-ton, $5,079,577 trade of July 1939. Seven months cumulative exports show the 1940 trade in scrap to be well under the levels set in 1939—exports in January-July period of the earlier year having amounted to 2,139,018 tons valued at $31,342,427 against the 1940 figure of 1,808,234 tons valued at $30,587,934.

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THE July 1940 trade of 327,129 tons included 326,546 tons of iron and steel scrap, 150 tons of tin plate scrap, 101 tons of tin plate circles, 226 tons of waste-waste tin plate, and 106 tons of terne plate scrap. Leading purchaser of iron and steel scrap was the United Kingdom with takings amounting to 140,365 tons. Japan ranked second with a trade of 113,926 tons, to be followed by Canada, 57,140 tons; Spain, 11,540 tons, and Mexico, 2,817 tons.

✦ ✦ ✦

United Kingdom Chief Market

CONTINUED large purchases of ingots, blooms, etc. again made the United Kingdom the month's leading export market with a total of 376,066 tons of iron and steel, which included 261,292 tons of non-alloy ingots, 57,995 tons of pig iron and 13,757 tons of non-alloy other steel bars. Non-alloy black steel sheets, 18,393 tons; pig iron, 10,311 tons; non-alloy other plates, 7,720 tons; and plain shapes, 7,198 tons were among the more important items of Canada's 69,969 ton-trade.

Argentina, with a total of 37,851 tons, ranked third, followed by Brazil, 21,207 tons; the Union of South Africa, 20,092 tons; China, 19,427 tons; Japan, 17,025 tons and British India, 13,629 tons.

✦ ✦ ✦

Scrap Exports Higher

THE leading purchaser of scrap in July was the United Kingdom with takings amounting to 140,365 tons. Japan ranked second with a trade of 114,076 tons, to be followed by Canada, 57,104 tons; Spain, 11,540 tons; and Mexico, 2,822 tons.

✦ ✦ ✦

Continued Decline in Imports

PIG iron was the chief commodity imported in July in point of tonnage received—the 1,067-ton total including 717 tons from Canada and 350 tons from British India. Receipts of spiegeleisen—662 tons—were all from Canada, while of the 319 tons of ferromanganese which entered the country 284 tons are accredited to Norway and 35 to Japan. Canada was the source of 444 tons and Mexico of 86 tons of the 531 tons of railway track material imported in July, while Sweden supplied the entire 256 tons of flat wire and steel strip brought in during the month.

✦ ✦ ✦

Scrap Receipts Up

RECEIPTS of scrap iron and steel in July amounted to 152 tons valued at $2,286—this total comparing with the single ton valued at $9 imported in June and with the 3,335-ton, $33,568 trade of July 1939. Canada supplied 151 tons and Mexico 1 ton of the July 1940 total.

✦ ✦ ✦

Miscellaneous Items in July Import Trade

IRON Ore: 249,397 tons (162,064 tons in June) coming principally from Chile, 152,900 tons; Brazil, 36,375 tons; Canada, 33,841 tons; and Cuba, 17,400 tons.

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MANGANESE Concentrates: 10-35 percent: None (none). **35 percent plus — Battery grade:** 1,339 tons (1,905 tons), all of which came from the Gold Coast. **35 percent plus — Other:** 37,681 tons (48,960 tons). The principal suppliers were U.S.S.R. (Russia) 11,588 tons; Cuba, 8,058 tons; Union of South Africa, 5,750 tons; Brazil, 4,194 tons; and the Gold Coast, 3,183 tons.

✦ ✦ ✦

EXPORTS of iron and steel wood screws during July 1940 totaled 435,739 gross valued at $47,932. Of this total the United Kingdom took 61,027 gross, valued at $11,665; British India, 59,930 gross valued at $10,766; Cuba, 47,412 gross valued at $6,711; China, 24,731 gross valued at $9,908; Philippine Islands, 11,242 gross valued at $2,590; Union of South Africa, 4,514 gross valued at $484; Salvador, 3,925 gross valued at $731; Venezuela, 3,014 gross valued at $600; Peru, 2,972 gross valued at $421; Colombia, 2,872 gross valued at $675; Costa Rica, 2,626 gross valued at $464; Canada, 2,143 gross valued at $231; Mexico, 2,134

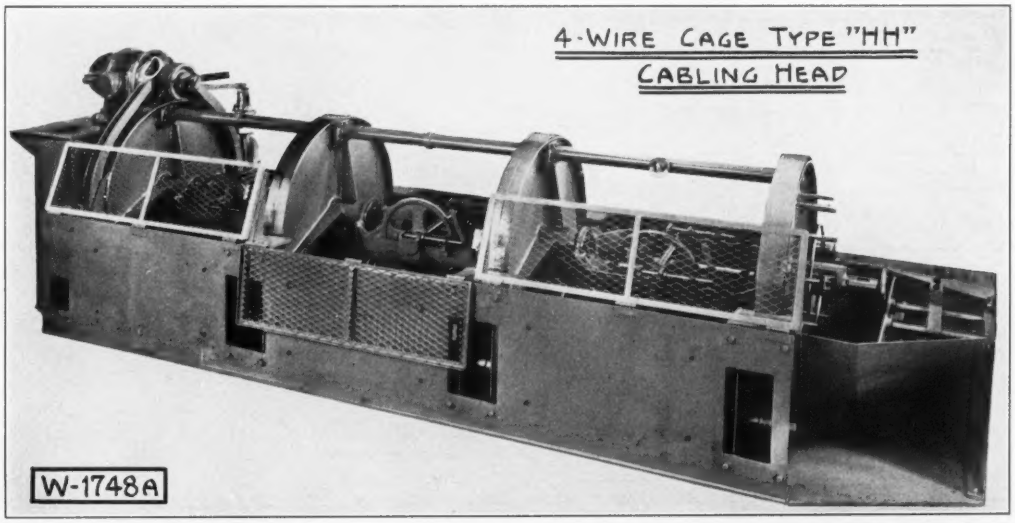
(*Please turn to Page 634*)

THE WATSON MACHINE COMPANY

ESTABLISHED 1845

PATERSON, NEW JERSEY, U. S. A.

HIGHEST MACHINE SPEEDS



16", 24", 30" & 40" SPOOL SIZES

American Iron & Steel Institute Production Statistics for July, 1940

TO those interested in figures particularly relating to wire and rod production, attention is called to the first column indicating the number of companies producing the capacities shown. The contrast between these figures and those provided by the Department of Commerce will show somewhat wide discrepancies, largely due to the fact that the Department of Commerce figures cover under each heading a greater number of companies than those shown in these Iron & Steel Institute figures.

35-200-6.40.

AMERICAN IRON AND STEEL INSTITUTE
Capacity and Production for Sale of Iron and Steel Products

July - 1940 (PERIOD)

		Number of companies	Items	Annual Capacity Net tons	Production for Sale—Net Tons: Current Month: Total	Current Month: Per cent of capacity	Current Month: Shipments: Export	Current Month: Shipments: To members of the industry for conversion into further finished products	To Date (7 Months 1940): Total	To Date: Per Cent of capacity	To Date: Shipments: Export	To Date: Shipments: To members of the industry for conversion into further finished products
STEEL PRODUCTS	Ingots, blooms, billets, slabs, sheet bars, etc.	33	1	xxxxxxx	551,332	xxx	353,882	91,124	2,578,300	xxx	1,074,435	609,640
	Heavy structural shapes	8	2	5,205,300	285,599	64.9	51,164	xxxxxxx	1,440,374	47.5	149,530	xxxxxxx
	Steel piling	4	3	328,000	13,027	47.0	1,478	xxxxxxx	92,029	48.2	9,375	xxxxxxx
	Plates—Sheared and Universal	20	4	6,095,450	360,564	70.0	68,209	1,878	2,146,790	60.5	312,147	12,264
	Skelp	8	5	xxxxxxx	83,891	xxx	15,875	26,672	376,288	xxx	56,507	144,939
	Rails—Standard (over 60 lbs.)	4	6	3,647,600	118,179	38.3	41,022	xxxxxxx	1,024,756	48.3	82,895	xxxxxxx
	Light (60 lbs. and under)	6	7	306,800	9,567	36.9	2,337	xxxxxxx	60,350	33.8	18,126	xxxxxxx
	All other (Incl. girder, guard, etc.)	2	8	118,000	401	4.0	-	xxxxxxx	16,901	24.6	2,382	xxxxxxx
	Splice bar and tie plates	15	9	1,300,200	39,828	36.2	1,604	xxxxxxx	353,887	46.8	6,149	xxxxxxx
	Bars—Merchant	35	10	xxxxxxx	400,200	xxx	58,277	33,205	2,339,875	xxx	269,731	183,537
	Concrete reinforcing—New billet	15	11	xxxxxxx	122,671	xxx	20,289	xxxxxxx	683,286	xxx	164,685	xxxxxxx
	Rerolling	18	12	xxxxxxx	13,258	xxx	259	xxxxxxx	81,879	xxx	4,517	xxxxxxx
	Cold finished—Carbon	18	13	xxxxxxx	57,619	xxx	1,599	xxxxxxx	360,922	xxx	8,570	xxxxxxx
	Alloy—Hot rolled	15	14	xxxxxxx	83,255	xxx	6,274	6,636	492,911	xxx	33,804	34,017
	Cold finished	14	15	xxxxxxx	7,381	xxx	132	xxxxxxx	50,014	xxx	1,492	xxxxxxx
	Hoops and baling bands	5	16	xxxxxxx	8,274	xxx	553	xxxxxxx	53,911	xxx	4,887	xxxxxxx
	TOTAL BARS	53	17	12,372,465	692,658	66.2	87,383	39,841	4,062,798	56.4	487,686	217,554
	Tool steel bars (rolled and forged)	15	18	110,220	5,319	57.1	518	xxxxxxx	38,201	59.5	2,907	xxxxxxx
	Pipe and tube—B. W.	13	19	1,815,860	104,108	67.8	4,773	xxxxxxx	540,103	51.1	44,990	xxxxxxx
	L. W.	10	20	1,246,340	34,261	32.5	3,340	xxxxxxx	192,588	26.5	21,126	xxxxxxx
	Electric weld	5	21	735,520	35,662	57.3	2,215	xxxxxxx	154,868	36.2	14,806	xxxxxxx
	Seamless	15	22	3,159,840	152,018	56.9	14,086	xxxxxxx	1,002,721	54.5	101,722	xxxxxxx
	Conduit	6	23	151,145	6,283	49.2	235	xxxxxxx	38,060	43.3	1,045	xxxxxxx
	Mechanical Tubing	13	24	554,825	24,353	51.9	2,906	xxxxxxx	152,570	47.2	10,465	xxxxxxx
	Wire rods	19	25	xxxxxxx	116,599	xxx	38,180	19,144	604,155	xxx	165,870	98,238
	Wire—Drawn	37	26	2,255,210	118,857	62.3	11,573	928	771,925	58.8	93,900	6,188
	Nails and staples	19	27	1,091,690	61,377	66.5	6,723	xxxxxxx	340,942	53.7	40,075	xxxxxxx
	Barbed and twisted	16	28	438,270	19,944	53.8	5,297	xxxxxxx	121,367	47.6	25,456	xxxxxxx
	Woven wire fence	15	29	772,790	20,657	31.6	194	xxxxxxx	149,980	33.3	1,404	xxxxxxx
	Bale ties	11	30	119,050	9,048	89.9	1	xxxxxxx	39,215	56.6	144	xxxxxxx
	All other wire products	6	31	27,030	2,025	88.6	-	xxxxxxx	8,250	52.4	-	xxxxxxx
	Fence posts	13	32	147,485	4,689	37.6	47	xxxxxxx	32,896	38.3	490	xxxxxxx
	Black plate	12	33	653,295	30,021	54.4	10,807	377	218,519	57.5	29,982	55,670
	Tin plate—Hot rolled	9	34	1,201,960	38,823	38.2	4,821	xxxxxxx	296,551	42.4	67,381	xxxxxxx
	Cold reduced	10	35	2,930,860	200,002	80.7	20,466	xxxxxxx	1,368,003	80.2	247,035	xxxxxxx
	Sheets—Hot rolled	26	36	xxxxxxx	476,206	xxx	51,415	16,031	2,960,589	xxx	307,187	85,945
	Galvanized	16	37	xxxxxxx	134,313	xxx	14,047	xxxxxxx	752,723	xxx	98,680	xxxxxxx
	Cold rolled	18	38	xxxxxxx	171,445	xxx	6,973	xxxxxxx	1,239,895	xxx	52,314	xxxxxxx
	All other	15	39	xxxxxxx	46,156	xxx	1,984	xxxxxxx	320,749	xxx	14,586	xxxxxxx
	TOTAL SHEETS	27	40	13,255,610	828,120	73.9	74,419	16,031	5,273,956	68.4	472,767	85,945
	Strip—Hot rolled	24	41	3,525,110	117,717	39.5	10,346	14,207	782,037	38.1	48,844	81,738
	Cold rolled	35	42	1,313,360	59,529	53.6	1,226	xxxxxxx	390,161	51.0	9,919	xxxxxxx
	Wheels (car, rolled steel)	5	43	424,385	13,495	37.6	84	xxxxxxx	107,787	43.6	2,416	xxxxxxx
	Axles	5	44	472,280	6,053	15.2	1	xxxxxxx	47,332	17.2	1,719	xxxxxxx
	Track spikes	11	45	327,275	9,030	32.6	173	xxxxxxx	66,506	34.9	2,491	xxxxxxx
	All other	3	46	9,100	803	104.4	-	xxxxxxx	5,616	106.0	-	xxxxxxx
	TOTAL STEEL PRODUCTS	134	47	xxxxxxx	4,173,839	xxx	835,385	210,202	24,896,782	xxx	3,606,186	1,312,176
	Estimated total steel finishing capacity based on a yield from ingots of 68.9 %	-	48	53,946,300	xxxxxxx	86.9	xxxxx	xxxxxxx	xxxxxxx	75.1	xxxxxxx	xxxxxxx
	Pig iron, ferro manganese and spiegel	26	49	xxxxxxx	506,175	xxx	91,679	178,295	3,053,676	xxx	269,102	829,324
	Ingot moulds	4	50	xxxxxxx	39,902	xxx	470	xxxxxxx	236,464	xxx	2,006	xxxxxxx
IRON PRODUCTS	Bars	10	51	160,600	2,488	18.3	11	274	16,201	17.3	105	1,441
	Pipe and tubes	3	52	109,377	3,985	43.1	40	xxxxxxx	21,598	33.9	581	xxxxxxx
	All other	3	53	71,180	1,369	22.7	479	373	7,261	17.5	1,477	2,017
	TOTAL IRON PRODUCTS (ITEMS 51 to 53)	12	54	276,247	7,842	33.6	530	647	45,060	28.0	2,163	3,458

Total number of companies included - 153

Total steel products produced for sale, less shipments to members of the industry for conversion into further finished products: Current month 3,963,637 *N.T.;* 86.9 *% of Finishing Capacity.*
To date 23,584,606 *N.T.;* 75.1 *% of Finishing Capacity.*
The above tonnages represent 68.9 *% of the ingots produced by companies whose products are included above.*

Progress and Trends of The Wire Industry

By J. Kenneth Beeson,
Assistant General Manager of Sales,
Pittsburgh Steel Co., Pittsburgh, Pa.
President of The Wire Association

THE year 1940 has seen certain significant developments in the fabrication of Ferrous and Non-Ferrous Wires, which indicate that the Industry is maintaining its progressive attitude in new processes and expanded uses for Wire. Very few people who are not in the Wire Industry realize the extensive use of Wire and articles fabricated from Wire. It is an item indispensable to our lives, and is found in more diversified products than any other fabricated metal. The vital importance of Wire, therefore, makes it necessary for those interested in its production and development to be forever searching for better methods of manufacture, better materials and new and improved uses.

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IN surveying the Wire Industry during the past year, it is evident that our Industry is becoming more and more cost-conscious, as is shown in the installation of mechanical devices for the increase in production and reduction in cost. The installations of straight line cleaning equipment, flash bakers, continuous wire drawing machines, etc. have increased over the past year and will continue to increase during the coming year. It has been noticed that with the installations of new and improved machinery has come an improvement and constancy in the quality of the wire produced.

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ONE of the most interesting developments of the year is the perfection of a substitute for Swedish Rods and Wire by certain domestic mills. Since the inception of the present war, Swedish material has been increasingly difficult to obtain, and until this year has been the only Rod and Wire product which has not been capable of manufacture in this country. The product now being manufactured domestically equals in all respects the imported product. Tests on finished valve springs have more than justified the confidence that this country can compete favorably.

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TREMENDOUS strides have been made in the production quality and marketing of Stainless Steel Wire. This branch of the industry, in its infancy yet, shows signs of becoming one of the important elements in wire manufacture. The dairy, automotive, refrigerator, welding and food products industries have given a great forward impetus to the consumption of this quality wire product.

MR. J. K. BEESON
President—The Wire Association
After graduating from Yale University in 1929, Mr. J. K. Beeson joined the Pittsburgh Steel Company, and worked in the Research Department making a thorough study of Wire specialties for a period of five years. In the year 1935 he was made Manager of Manufacturers' Products Sales. One year later he was made Assistant General Superintendent at the mill, and in 1938 became Assistant Manager of Sales. In April 1939 he was appointed Assistant General Manager of Sales which position he now holds.

Gradually, also, processors of Stainless Wires are becoming less afraid of working Stainless, and with the splendid cooperation of metallurgical and mill engineers are gaining confidence in its practical aspects. I look forward to a considerable increase in its use over the next few years to come.

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CERTAIN spring forming machines were developed in the past year which improved the efficiency and reduced costs of spring manufacture. These machines required more precise specification of Spring Wire than was necessary prior to their advent. It was heartening to find the wire industry and its technical men develop these increased physicals in a very short time. The Spring Wire of today is a far cry from that produced several years ago.

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THE wire industry has several important jobs to do in the future. Its first and foremost is to put its house in order for the production of the necessary materials for National Defense. With this aim in mind, the Wire Association has formed an Emergency Advisory Committee to act as clearing house for the members of the Wire Association and the Governmental Agencies on any question involving specifications, production details and metallurgical aid. This Committee is for the aid of those members who may have ideas or problems and wish to clear with the Governmental Departments through the Wire Association. It is further designed to be of assistance to the Governmental Agencies in disseminating information to the Wire Association Members.

ANOTHER vital job the wire industry has is to preserve its markets, built up in the past years. The wire industry cannot become a rod industry, allowing its conversion from rods to wire to pass into other hands. There is too much of an investment by wire producers in converting equipment to allow such an eventuality. If the production of wire is removed from the industry, there are two solutions. The first is for the wire industry to install finishing equipment to produce finished articles, such as are represented today in the field known as wire products. The wire industry does not want to compete in a large way with its customers, but if its customers force the issue there is no alternative.

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THE other solution is the narrowing of the spreads in prices between rods and wire. This solution cannot undo the acts of the past, but can prevent further spread of a situation which means the lifeblood of the industry-tonnage and profits for a tremendous investment.

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ONE hears on all sides today that the uncertainty of the future holds back certain developments. The future has been and always will be uncertain, and it is time that the members of our industry realize this fact and proceed along sound constructive lines —not delaying well formed plans for this and that to happen—but acting.

Present Trend In Wire Industry

By B. L. McCarthy,
Chief Metallurgist,
Wickwire Spencer Steel Co., Buffalo, N. Y.

THE extension of the use of stainless steel wire in various fields is having a beneficial effect on the manufacture of this material. A portion of this increase is due to new developments in Electrolytic Polishing.

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THE trend towards straight line operations including multiple draft machines, faster baking times, etc., continues.

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THE increase in fatigue life of wire springs by the use of shot blasting has been a very beneficial development in the last few years, and its use is being extended.

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THE use of the Bell type annealers is being extended and results indicate that much of the troubles due to non-uniformity resulting from the older pot type annealers is being reduced.

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THE use of the metallurgical microscope is becoming more common in connection with the control of heat treatments and the control of grain size.

THE use of fine grain steel for the manufacture of steel wire for tempering purposes is increasing.

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WITH the present situation existing in Europe the American Wire manufacturers have been asked to duplicate numerous items which were previously supplied from European wire makers. This has provided means for comparison of American and European wire manufacturing practices. Indications are that the European wire manufacturers employ more labor and poorer steel quality. This is in line with our expectations because of the difference that exists between labor costs and raw materials.

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THERE is every reason to believe however that consumers will, after they have accustomed their uses to American made products, like the improvement in quality of the American material well enough to enable us to retain much of this business even in the face of an unfavorable price competition which will follow when hostilities cease and European shipments are renewed.

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THE shortage of Swedish rods is providing a good opportunity for American Wire Producers to develop suitable substitutes with the consumers' attitude favorable. In the past the consumers' attitude has been one of the biggest obstacles to overcome. With the present situation, where we have the consumer and the manufacturer co-operating there is reason to believe that definite inroads will be made that will be retained even after Swedish shipments have been resumed.

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THE defense emergency has made co-operation between the Government and industry essential and the Wire Association is to be commended for its quick realization of this fact as indicated by the formation of the Emergency Advisory Committee.

Process Developments During 1940

By Kenneth B. Lewis,
Consulting Wire Mill Engineer,
Worcester, Mass.

THE year now drawing to a close has been, on the whole, a pretty satisfactory one in the wire mills. Business, though spotty, has been generally brisk, with improvement in all lines in a fair degree of uniformity. The war has tended to quicken all lines rather than to cause intense local fevers as in 1915-18. The writer predicted, just a year ago, that this war, in its effect on wire, would not follow the previous pattern, and this has proven true. Barbed wire has had a good run, of course; wire rope has done very well, with large exports to England, but they are not the war babies they used to be.

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TWO lines which have been greatly stimulated, are signal strand and airplane strand, the latter a stainless steel. These are both fine wires and do not greatly affect tonnage. Through the efforts of the Wire Association the discrepancies between army specifications and commercial practise have been smoothed away, and signal strand is going nicely. Defense against submarines has involved less consumption of wire rope. The new protective devices do affect one corner of our industry, in a way which probably should not be publicly discussed.

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THE year has seen no large new installations nor any extensive reconstruction. Nevertheless there has been a steady overhauling of facilities, of the sort which does not interrupt production. This work has followed the pattern established in the past few years.

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CLEANING houses have been shifted to straight line and box bakers replaced by flash bakers. Single draft benches are steadily giving way to continuous machines. Batch annealing is moving rapidly in the direction of thin-walled containers, atmosphere control, and closer temperature regulation.

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NO particular news has come in regarding galvanizing or tinning, but strand treatment for physicals, as in patenting and tempering, is being done commercially by means of the electrical resistance of the strands. This system, which some members of the Wire Association inspected at the last Cleveland meeting, has now had a more extended trial in several installations, and both process and product seem sound. The product has properties differing slightly from those of fuel fired units, and apparently very acceptable. It is understood that the sponsor of this system will have a demonstration unit in action at this year's Cleveland meeting.

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INSPIRED by the success of the flash baker, a manufacturer has begun experiments with a sort of flash annealer, designed to lie in the line like an acid tub and be serviced by the cleaning crane. If successful this unit would solve some problems for the small mill which has scarcely enough tonnage to warrant either a gantry crane for straight line cleaning or such a crane as is needed for the large unit weights of the modern annealing outfit. A "noble experiment", and we wish it well.

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ANOTHER problem of the small mill has been neatly solved; that of the boiler house for heating acid. At many plants this is now the sole function of the boiler, and because of the enormous capacity needed to bring a fresh tub up to heat quickly, as compared to that needed to keep it working, there is a good deal of excess capacity and licensed labor. One ingenious operator heats up a new tub by "dunking" pins of rods out of the flash baker, and is able to get by with a small automatic boiler without licensed attendance.

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IN the wire room the most interesting item is the movement toward harnessing in a practical way the known benefits of "backpull". The subject is one which **John Callaghan** would describe as "esoteric", and few people have the patience to wade through the mathematical implications, but machines have been built under the Smith-Stringfellow patent, one of which was on display during the Worcester Regional Meeting. Such advantages as can be established by instruments have checked out nicely with the formulas. Those relating to die life and physical properties naturally await the conclusion of long runs under mill conditions. It begins to be clear that the process lends itself readily to continuous drawing.

The Discussions at The Wire Association Meetings Will Be Published in Detail in the January, 1941 Issue of Wire and Wire Products.

✦ These Discussions — In Connection With the Published Papers Will Contain Information of Great Value To All Wire Production Men — Be Sure To Secure A Copy. ✦

1940 Developments In The Wire And Cable Industry

By E. W. Clark,
Mechanical Engineer, Wire & Cable Dept.,
General Electric Co., Schenectady, N. Y.

THE year of 1940 has been noteworthy in the wire and cable industry in that many developments previously started have been completed and have been incorporated in regular manufacturing procedure.

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IN bare copper wire manufacture considerable progress has been made in improving the surface of wire and in obtaining better control of its physical characteristics.

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THE problem of improving wire surface has been attacked in various ways by different manufacturers. I think it is generally conceded that most imperfections in the surface of wire are caused in one way or another during the process of hot rolling the rods from which wire is drawn. Even the most modern equipment properly operated and controlled does not seem to give a good enough surface on the rod to meet the requirements for wire demanded for some special usage.

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IN order to meet these requirements, some concerns are obtaining wire, absolutely free from surface imperfections, by mechanically removing the surface of standard hot-rolled rods to a depth sufficient to take off all the imperfections due to rolling. Another manufacturer has developed a new pickling and cleaning process that is claimed to remove the surface of rod to a depth great enough to insure its being drawn into wire with a satisfactory surface for all uses. Likewise, still another concern has spent a large amount of money in developing an extrusion process which eliminates the hot rolling. Wire drawn from this extruded rod has a smooth surface free from slivers, pits, and scale.

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THERE may have been other developments of the same type but, at any rate, the result has been that a generally better grade of bare copper wire can, when required, be produced today than at any previous time, and the work of improvement is being continued.

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IMPROVEMENTS have been made in the design and construction of reels and spools and in the machinery for winding wire on them. This has enabled manufacturers to draw, anneal, and ship wire on the original drawing spools without rewinding and in much larger packages than in the past. Respooling devices have been developed which permit of removing the wire from these larger spools without damage and at high rewinding speeds.

✦ ✦ ✦

E. W. CLARK
Mechanical Engineer, Wire and Cable Section, General Electric Co., Schenectady, N. Y., Vice President, The Wire Association.

IN the magnet wire field, new varnishes and enamels have been developed, some of which when applied to wire, provide an insulation with a much greater resistance to abrasion and which can withstand higher temperatures without deterioration. These characteristics have permitted the elimination of the protective fabric insulation in many cases, with the resultant reduction in winding space required.

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FIBRE glass insulation on wire is being used by some manufacturers where high temperatures in operating apparatus are encountered. Its physical and electrical qualities permit of a thinner insulation and, therefore, a saving in winding space in coils.

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CONSIDERABLE attention has been given to improving packing methods and shipping containers, resulting in improved appearance and greater convenience in handling.

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IN types of cable other than magnet wire developments tending to improve insulation have been carried out. Synthetic rubbers are now available to replace the use of natural rubber in insulation. Some of these have qualities superior to rubber in their ability to withstand deterioration in oil and to resist oxidation to a greater extent.

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SYNTHETIC resins are now being used that have electrical and mechanical qualities so good that insulation thickness can be reduced and the braid and weather-

(*Please turn to Page 626*)

THE WIRE ASSOCIATION — 1939-40

Vice President
B. L. McCARTHY
Chief Metallurgist
Wickwire Spencer Steel Co.,
Buffalo, N. Y.

President
J. K. BEESON
Asst, Gen. Mgr. of Sales,
Pittsburgh Steel Co.,
Pittsburgh, Pa.

Vice President
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Mechanical Engineer,
Wire & Cable Section,
General Electric Co.,
Schenectady, N. Y.

Past President
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Vice Pres., Chg. of Operations,
Continental Steel Corp.,
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Past President
F. A. WESTPHAL
Superintendent, Wire Mills,
Sheffield Steel Corp.,
Kansas City, Mo.

RICHARD E. BROWN, Executive Secretary,
Stamford Trust Co. Building, Stamford, Conn.

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Republic Steel Corp., Massillon, Ohio

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M. A. Kent, Vice President,
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B. L. McCarthy, Chief Metallurgist,
Wickwire Spencer Steel Co.,
Buffalo, N. Y.

John A. Moritz, Superintendent,
Wire Mills, Keystone Steel & Wire Co.,
Peoria, Illinois

Sidney Rolle, Assistant Manager,
Scomet Engineering Co.,
New York, N. Y.

F. A. Westphal, Superintendent,
Wire Mills, Sheffield Steel Corp.,
Kansas City, Mo.

✦ ✦ ✦

THE Wire Association is a non-profit organization of wire mill executives, superintendents and foremen. It also includes plant engineers, traffic men, and all others engaged in the production of cold drawn bars, rods, wire, strip, insulated wire and cable, and the manufacture and fabrication of finished wire products, including cold headed, extruded and other cold worked metal products.

THERE are separate divisions for all the separate major interests in the wire industry, steel, iron, brass, copper, alloy, and precious metals, together with divisions relating to drawing, cold working, cold heading, extruding, fabricating, forming, spring making, wire cloth, wire rope, bare and covered electric wire and cable and all other forms of wire and wire products.

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PURPOSES

ITS specific purpose is to improve production methods and afford a clearing house for ideas on management problems, technical problems, and research work in all phases of practical wire drawing and wire working, and to develop and maintain friendly relations among the members.

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ACTIVITIES:

The Association functions along the following lines:

1. The use of the Association headquarters as a central clearing house for information and data of all kinds which may be of interest to members.
2. The exchange of ideas on processes of production including machinery, technical processes, etc.
3. The establishment and maintenance of friendly relations among the members of the association and the development of sectional and national meetings to discuss matters of mutual interest.
4. Studies of production methods and analysis of production costs.
5. Developments in the use of new materials and new applications of existing materials and by-products.
6. Research and collection of information on personnel management, including such factors as labor turnover, seasonal changes in the demand for employees, wage scales, etc.
7. Standardization and simplification as a means for the effective elimination of waste.
8. Such other subjects as may be determined upon.

High Lights of the Convention Program

This year's meeting will be unusual in that several speakers will present original researches and present demonstrations in connection with their presentations. ✦ ✦ ✦ ✦ ✦ ✦

Association Headquarters

AS usual the Wire Association will maintain a headquarters suite of rooms in the hotel for the purpose of enabling members to make appointments and to hold "get-together" sessions at such times as they are not at the meetings. These rooms will be open from 9:00 A. M. to 11:00 P. M. from Monday to Thursday, and on Friday from 9:00 A. M. to 6:00 P. M., during the Convention week. All registered members and guests are welcome. The room numbers will be displayed at the registration booth in the hotel.

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The Annual Wire Association Luncheon

THE guest speaker at this year's luncheon will be

C. M. White,
Vice-President of Operations,
Republic Steel Corp.
TOPIC: "Steel Quality and Labor Relationship"

✦ ✦ ✦

MEMBERS are at liberty to invite guests to hear this interesting speaker.—Members and guests of other societies participating in the National Metal Congress are also invited to attend.

✦ ✦ ✦

The Mordica Memorial Lecture

THE **Mordica Memorial Lecture** will be presented by

Benjamin Lewis McCarthy,
Chief Metallurgist,
Wickwire Spencer Steel Co.,
Buffalo, New York
TOPIC: "The Use of Plane Polarized Light and Sensitive Tint Illumination in the Analysis of the Microstructure of Steel"

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IT is expected that the lecture will take approximately one hour to deliver and while it is usually not considered that papers or lectures of this type are open for discussion, Mr. McCarthy has stated that in this instance he hopes that there will be discussion of the lecture at the meeting, because he finds that there is usually more good obtained from such a discussion than from simply presenting the paper and stopping there.

BENJAMIN LEWIS McCARTHY
Vice President
The Wire Association

Born in Lockport, New York, in 1895. In 1913 was employed as Assistant Chemist by Simonds Saw and Steel Co. In 1916 was employed by Wickwire Steel Co., now known as Wickwire Spencer Steel Co., as Assistant Chief Chemist. Three years later was promoted to Chief Chemist and Metallurgist. Now in charge of the Chemical and Metallurgical Laboratories and directs research and special investigation into the Chemistry and Metallurgy of steel, steel wire and wire products. Member of the Wire Association, The American Society for Testing Materials, and the American Society for Metals. Awarded the Wire Association Medal for the most meritorious paper on wire manufacture or fabrication during the years 1935 and 1937.

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THE lecture will be delivered the afternoon of Wednesday, October 23rd at the Wire Association annual meeting.

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Smoker

THIS year's Smoker is once more under the direction of Mr. A. R. Zapp, Manager of the Firthaloy Division of Firth-Sterling Steel Company, and a contract has been made for the definite employment of particular acts. It is expected that in view of the success of the 1939 Show, which was under the direction of the same group, that this year's Smoker will be even more interesting and attractive than those of previous years.

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Plant Inspection

ON Thursday afternoon there will be an Plant Inspection at the Trauwood Engineering Company, 1740 East 23rd Street, Cleveland, Ohio, where there will be an electric direct resistance wire treating unit in operation. Those desiring to make this Plant Inspection are requested to register their intention at the Wire Association Registration Desk in the lobby of the Carter Hotel not later than Thursday morning, 9:30 A. M. Since the plant of the Trauwood Engineering Company is only a short distance from the Hotel those making the Plant Inspection trip will gather at the Hotel about 1:30 and use taxicabs for the purpose of reaching the plant.

The Technical Activities

BRIEF descriptions follow of the activities, lectures, motion pictures and papers to be presented at the meeting, which are not published in this issue of "WIRE & WIRE PRODUCTS" in detail.

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PAPER: "Galvanizing Characteristics of Different Types of Steels"

By Robert W. Sandelin,
Metallurgist,
Atlantic Steel Company,
Atlanta, Georgia

IN order to continue the work required for the presentation of this paper up to the last possible moment, it was found impossible to have it ready for preprinting in the October Issue of WIRE & WIRE PRODUCTS.

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HOWEVER, copies of the paper were placed in the hands of the Directors prior to the Meeting and the paper, in its entirety, will be published in the November Issue of WIRE & WIRE PRODUCTS.

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MR. SANDELIN has completed a series of galvanizing experiments in which he has gathered data on appearance, bend tests, and strip tests on over 200 samples.

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IN addition, metallographic experiments were made to determine the nature of various types of coatings followed by work to determine the difference in the diffusion rates of the various steels.

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PAPER: "The Endurance Properties of Hard Drawn Wire from Various Kinds of Copper"

By John N. Kenyon, Instructor,
Civil Engineering Department,
Columbia University,
New York, New York

THIS paper will present an investigation of several different kinds of copper wire and be in the nature of a preliminary report giving trends, as it is expected that the study will not be finished for another six months.

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IT will include a brief description of the apparatus used in making the fatigue tests, the objects of the tests and the trend of the results.

PAPER: "Tungsten Carbide Dies and Tools"

By James R. Longwell,
Chief Engineer,
Carboloy Co., Inc.,
Detroit, Michigan

MR. LONGWELL will deliver an off-the-record discussion relating to the development and uses of tungsten carbide dies and tools.

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INCLUDED in the discussion will be many new and unusual features and uses for these tools as developed by the Carboloy Company during the past year.

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MOTION PICTURE: "Copper From Mine to Market"

Phelps Dodge Copper
Products Company,
New York, New York
Narrator—H. A. Stout

FEW industrial film productions have been made to date with the care, precision and sweep of this high-powered story of the production of copper and copper rod, wire and cable.

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THE picture describes the production of copper from the mine through the smelting and refining processes. Then we go into the mill where copper wire bars are hot rolled to sizes suitable for fabricating processes. This rod is then drawn through a series of dies and on to bobbins or reels in preparation for fabrication.

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WE are then shown the manufacture of wire and cable in a wide variety of sizes and types of construction together with methods of stranding copper conductor, paper insulated high voltage cable and applying protective lead coatings to the cable by means of hydraulic pressure to make the cable ready for the rigors of service.

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FINALLY, safety and testing methods are shown which insure the dependable performance of the finished product.

MOTION PICTURE: "Application of Tungsten Carbide Tools and Dies"

Firth Sterling Steel Company,
McKeesport, Pa.

NOT only have many new uses been developed during the past year for tungsten carbide dies and tools but there is every indication of a rapid expanse throughout the industry in new and diversified applications.

✦ ✦ ✦

THIS motion picture is a result of investigation by representatives of the Firth-Sterling Steel Company as to various uses of such tools and dies and presents actual operating photographs taken in the plants of many of their customers and showing some very unusual and interesting applications in the production of wire and the manufacture of wire products.

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AT the conclusion of the picture a representative of the company will be glad to answer any questions presented by those in the audience.

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PAPER: "Design and Operation of a New Copper Wire Drawing Plant"

By H. Blount, Mfg. Engineer,
Point Breeze Works, and
J. D. Wiltrakis, Engineer,
Kearny Works,
Western Electric Company

IN connection with the presentation of this paper there will be a motion picture showing the processes of drawing .036 copper wire at the rate of 10,000 feet per minute.

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THE picture will also show the general operations in connection with the Kearny Works of the Western Electric plant at Kearny, New Jersey.

Every wire mill production executive engaged in the manufacture or fabrication of wire and wire products of any kind is invited to join the Wire Association and attend these meetings. ✦ ✦ ✦ ✦ ✦

THE WIRE ASSOCIATION ANNUAL MEDAL AWARDS

For the Most Meritorious Paper on Wire Manufacture or Fabrication During the Year

1934 — EDWARD J. P. FISHER
Metallurgist, Keystone Steel & Wire Co., Peoria, Ill.
Title of Paper: "COLD DRAWN STEEL SPRING WIRE"

1935 — BENJAMIN LEWIS McCARTHY
Metallurgist, Wickwire Spencer Steel Co., Buffalo, N. Y.
Title of Paper: "GRAIN SIZE AND ITS INFLUENCE ON THE MANUFACTURE OF STEEL WIRE"

1936 — ROBERT NOTVEST
Chief Engineer, Welding Division, J. D. Adams Mfg. Co., Indianapolis, Ind.
Title of Paper: "STEEL FOR ARC WELDING ELECTRODES"

1937 — BENJAMIN LEWIS McCARTHY
Chief Metallurgist, Wickwire Spencer Steel Co., Buffalo, N. Y.
Title of Paper: "ABNORMAL GRAIN GROWTH AND THE ANNEALING OF LOW CARBON STEEL WIRE"

1938 — WALTER R. BLOXDORF
Metallurgist, The MacWhyte Co., Kenosha, Wis.
Title of Paper: "WIRE ROPE"

1939 — STANLEY P. WATKINS
Manager, Sales Development, Rustless Iron and Steel Corp., Baltimore, Md.
Title of Paper: "THE MANUFACTURE AND USE OF STAINLESS STEEL WIRE"

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HONORABLE MENTIONS

1935 — L. D. SEYMOUR
Metallurgist, Rod and Wire Dept., Youngstown Sheet & Tube Co., Youngstown, O.
Title of Paper: "COLD HEADING WIRE"

R. A. SCHATZEL
Superintendent, General Research Laboratories, General Cable Corp., Rome, N. Y.
Title of Paper: "HARD AND SOFT COPPER WIRE"

1936 — BENJAMIN LEWIS McCARTHY
Metallurgist, Wickwire Spencer Steel Co., Buffalo, N. Y.
Title of Paper: PLASTIC DEFORMATION IN WIRE DRAWING"

1937 — ROBERT W. SANDELIN
Metallurgist, Atlantic Steel Co., Atlanta Ga.
Title of Paper: "A METALLURGICAL STUDY OF THE FACTORS AFFECTING THE QUALITY OF GALVANIZING"

ALLAN B. DOVE
Chemical Engineer, Canada Works,
The Steel Company of Canada, Ltd., Hamilton, Ont., Canada.
Title of Paper: "A. C. ELECTRO PICKLING—A BETTER METHOD OF PICKLING"

1938 — RODMAN R. TATNALL
Metallurgist, Morgan Works, Wickwire Spencer Steel Co., Worcester, Mass.
Title of Paper: "RESILIENCE OF SPRINGS"

JOSEPH A. DOYLE
Vice President, W. S. Rockwell Co., New York, N. Y.
Title of Paper: "HEATING COPPER WIRE BARS"

The
ANNUAL MEDAL AWARD
OF THE
WIRE ASSOCIATION

For the Most Meritorious Paper on Wire Manufacture or Fabrication During the Year

ALL members of the Wire Association are cordially invited to submit technical papers either for publication in "WIRE & WIRE PRODUCTS" during the year or for presentation before the Annual Wire Association Meeting at Chicago, October 21-25, 1940.

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FOR 1940 and subsequent years a medal will be awarded in each of the two major divisions of the activities of the Association, to the papers coming nearest to the requirement set forth above.

\+ + +

CONSIDERATION for the Medal Awards is not limited to the papers presented at the Annual Meeting, but is given to all papers submitted by members and published in "WIRE & WIRE PRODUCTS" during the year.

\+ + +

SELECTION of papers to be presented at the Annual Convention rests in the hands of the Joint Programme Committee and the Board of Directors of the Wire Association.

\+ + +

ALL papers submitted become the property of the Wire Association and the Board of Directors constitutes the Committee on Awards.

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ADDITIONAL information may be obtained by addressing:

RICHARD E. BROWN,
SECRETARY,
THE WIRE ASSOCIATION
Stamford Trust Co. Bldg.,
STAMFORD, CONNECTICUT

✣ PROGRAM ✣

Wire Association Convention---1940

Cleveland, O., October 21-25. Association Headquarters — Hotel Carter

✦ ✦ ✦

The Exposition and Show of the National Metal Congress Will Be Open from Monday to Friday Inclusive, All Day and Every Evening During the Week Except Thursday Evening.

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Wire Association Headquarters at The Carter Hotel Will Be Open From 9:00 A. M. to 11:00 P. M. During the Entire Convention—Come and Get Acquainted!

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THERE WILL BE A REGISTRATION FEE OF $5.00 FOR THOSE ATTENDING THESE TECHNICAL SESSIONS AND INFORMAL MEETINGS

✦ ✦ ✦ ADMISSION WILL BE BY BADGE ONLY ✦ ✦ ✦

Open Discussions Will Be Held On the Papers Presented and These Discussions Will Be Published in the January, 1941, Issue of Wire and Wire Products.

PROGRAM COMMITTEE

Chairman

Sidney Rolle, Assistant Manager,
Scomet Engineering Co., New York, N. Y.

John A. Moritz, Supt. Wire Mills,
Keystone Steel & Wire Co.,
Peoria, Illinois.

William H. Bassett, Jr., Manager,
Metallurgical Development,
Anaconda Wire & Cable Co.,
Hastings-on-Hudson, N. Y.

D. D. Buchanan, Assistant General Manager,
Union Drawn Steel Division, Republic Steel Corp.,
Massillon, Ohio.

E. W. Clark, Mechanical Engineer,
Wire & Cable Section, General Electric Co.,
Schenectady, N. Y.

Richard E. Brown, Publisher,
"Wire & Wire Products,"
Stamford Trust Co. Bldg., Stamford, Conn.

ANNUAL DINNER—STAG SMOKER

A. R. ZAPP,
Manager, Firthaloy Division,
Firth-Sterling Steel Co., McKeesport, Pa.
CHAIRMAN OF DINNER COMMITTEE

MEETING ROOMS

J. G. McGREEVY,
Vice President,
Apco Mossberg Co., Attleboro, Mass.
CHAIRMAN OF COMMITTEE

The Technical Sessions End Thursday in Order that Friday May Be Available To Make A Thorough Inspection of the National Metals Exposition.

MONDAY, OCTOBER 21	10:30 A. M.	12 NOON
	DIRECTORS' MEETING	PROGRAM COMMITTEE LUNCH

--- The Technical Sessions ---

ALL RESEARCH PAPERS ARE PREPRINTED IN THE OCTOBER ISSUE OF WIRE AND WIRE PRODUCTS

The Discussions and the Mordica Memorial Lecture Will Be Printed in the January, 1941 Issue of Wire and Wire Products

MONDAY, OCTOBER 21

Afternoon Session — 2:30 P. M.

F. A. Westphal, Superintendent, Wire Mills, Sheffield Steel Corp., Kansas City, Mo.
Chairman of Meeting

PAPER: "Tungsten Carbide Dies and Tools"	By James R. Longwell, Chief Engineer	Carboloy Co., Inc., Detroit, Michigan
PAPER: "Recent Developments in Heating Copper Wire Bars"	By Joseph A. Doyle, Vice President	W. S. Rockwell Company, New York, New York
PAPER: "Electric Direct Resistance Wire Treating"	By J. P. Zur, Engineer	Trauwood Engineering Co., Cleveland, O.

TUESDAY, OCTOBER 22

Morning Session — 9:30 A. M.

Hugh E. Brown, Director of Research, The W. S. Tyler Co., Cleveland, O.
Chairman of Meeting

PAPER: "Lime For Wire Drawing"	By D. E. Washburn, Chief Chemist	American Lime & Stone Div., The Warner Company, Bellefonte, Pa.
PAPER: "Electro Chemical Applications in the Wire Industry"	By Dr. C. L. Mantell, Consulting Engineer	New York, New York
MOTION PICTURE: "Application of Tungsten Carbide Tools and Dies"		Firth Sterling Steel Company, McKeesport, Pa.

TUESDAY, OCTOBER 22

Afternoon Session — 1:30 P. M.

Paul R. Fast, Superintendent, Belden Mfg. Co., Chicago, Ill.
Chairman of Meeting

PAPER: "The Endurance Properties of Hard Drawn Wire from Various Kinds of Copper"	By John N. Kenyon, Instructor, Civil Engineering Department	Columbia University, New York, New York
PAPER: "Reactive Wire Drawing"	By H. A. Stringfellow,	Worcester, Mass.
MOTION PICTURE: "Copper From Mine To Market"	Narrator—H. A. Stout	Phelps Dodge Copper Products Company, New York, New York

WEDNESDAY, OCTOBER 23

Morning Session, 9:30 A. M.

A. M. Reeder, Metallurgical Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Chairman of Meeting

PAPER: "What Does Good Laboratory Practice Do To Help Production In the Steel Plant?"	By Geo. P. Lenz, Jr., Metallurgist	Union Drawn Steel Div., Republic Steel Corp., Massillon, Ohio
PAPER: "Galvanizing Characteristics Of Different Types of Steels"	By Robert W. Sandelin, Metallurgist	Atlantic Steel Company, Atlanta, Georgia

C. M. WHITE,
Vice President in
Charge of Operations,
Republic Steel Corporation

C. M. WHITE, vice president in charge of operations, Republic Steel Corporation, was formerly a lumberman, tanner, telephone lineman, railroad construction worker and steel worker.

✦ ✦ ✦

HE was born in Oakland in the Alleghenies in Western Maryland. His father was in the lumber business, so while little more than a boy, he went into the woods and worked with the cutting gangs, ran sawmills and generally learned all about lumber, from the living trees to two-by-fours.

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HE got his grammar school education in Hutton, Md., and later studied mechanical engineering and graduated from Maryland University. During his vacations he climbed telephone poles, tanned leather and helped build railroads.

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IN 1913 he took his first steel job as a machinist helper with the American Bridge Co. at Ambridge. He then got a job as millwright helper in a sintering plant and in two years ended up as the plant superintendent. This was the beginning of his association with Jones & Laughlin.

✦ ✦ ✦

AT the end of the two years he was made assistant blast furnace superintendent of the Eliza Works and then master mechanic in charge of construction maintenance and power. He next went to the company's South Side Works as assistant to the general superintendent.

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FOR a few years he left steel making and went into the railroad business as general superintendent of the Jones & Laughlin subsidiary railroads in Pittsburgh and Aliquippa.

✦ ✦ ✦

IN 1927 WHITE was appointed assistant general superintendent of the Aliquippa Works and two years later was made general superintendent. His experience here was of especial value because the Aliquippa Works is one of the largest self-contained steel plants in the country and he was brought into direct contact with virtually every phase of steel making.

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IN 1930 he went with Republic as assistant vice president in charge of operations and was made vice president in charge of operations in 1935.

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HE is cordial, friendly and affable, but gives a definite impression that he can be equally firm should the occasion arise. MR. WHITE was married in 1918 to HELEN GORDON BRADLEY, Lonaconing, Maryland. He has one daughter, Jean. They live in Cleveland.

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WEDNESDAY, OCTOBER 23

1:00 P. M. — WIRE ASSOCIATION LUNCHEON — HOTEL CARTER

GUEST SPEAKER — C. M. White, Vice-President of Operations, Republic Steel Corp. — TOPIC: "Steel Quality and Labor Relationship"

(Members are at liberty to invite guests to hear this interesting speaker. Members and guests of other societies participating in the National Metal Congress are also invited to attend.)

WEDNESDAY, OCTOBER 23 Annual Meeting of The Wire Association

Afternoon Session — 3:00 P. M.

— The Medal Award —

AND THE

MORDICA MEMORIAL LECTURE

To Be Presented By
B. L. McCarthy, Chief Metallurgist,
Wickwire Spencer Steel Co.,
Buffalo, New York

TOPIC: "The Use of Plane Polarized Light and Sensitive Tint Illumination in the Analysis of the Microstructure of Steel"

WEDNESDAY, OCTOBER 23

Evening — 7:30 P. M.

ANNUAL DINNER — STAG SMOKER — THE CARTER HOTEL

THURSDAY, OCTOBER 24

Morning Session — 9:45 A. M.

C. S. Gordon, Wire Development Engineer,
Bell Telephone Laboratories, Inc.,
New York, N. Y.
Chairman of Meeting

PAPER: "Design and Operation of a New Copper Wire Drawing Plant" — By H. Blount, Mfg. Engineer, Point Breeze Works, and J. D. Wiltrakis, Engineer, Kearny Works — Western Electric Company

(This paper will be illustrated by both motion picture and lantern slides describing drawing .036 copper wire at 10,000 ft. per min.)

PAPER: "Development of Apparatus For Shaving Copper Wire Commercially" — By C. E. Weaver, Dev. Engineer, Works Laboratory — General Electric Company, Schenectady, New York

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THURSDAY, OCTOBER 24

Afternoon Session — 1:30 P. M.

PLANT INSPECTION
Electric Direct Resistance Heat Treating of Wire

Trauwood Engineering Co.,
1740 East 23rd St.,
Cleveland, O.

THURSDAY EVENING

OCTOBER 24—7:00 P. M.

AMERICAN SOCIETY FOR METALS DINNER — HOTEL STATLER

(Tickets for this dinner may be obtained at The Wire Association Registration Desk)

Wire Association Membership List October 1, 1940

ADAM, WILLIAM, JR., Vice President,
Ajax Electric Co.,
Frankford Ave. & Allen St.,
Philadelphia, Pa.

ADAIR, H., Gen. Foreman,
Northwestern Steel & Wire Co.,
Sterling, Illinois.

AKIN, W. M., Vice President,
Laclede Steel Co.,
Arcade Bldg., St. Louis, Mo.

ALDRIDGE, D. W., Assistant Works Manager,
British Insulated Cables, Ltd.,
Prescot, Lancashire, England.

ALKINS, DR. WM. E., Mgr. of Research Dept.,
Thomas Bolton & Sons, Ltd.,
Oakamoor, North Staffordshire, England.

ALLEN, ANTHONY J., Sales Representative,
Pittsburgh Steel Company,
500 Fifth Avenue, New York, N. Y.

ANJESKEY, A. F., Sales Manager,
Cleveland Tramrail Division of the
Cleveland Crane & Engineering Co.,
Wickliffe, Ohio.

ATKINSON, L., Superintendent,
Frost Steel & Wire Co., Ltd.,
250 Lottridge St.,
Hamilton, Ontario, Canada.

BABB, C. W., Factory Superintendent,
The Columbus Bolt Works,
291 N. Water St., Columbus, Ohio.

BACKER, SIMON, General Manager,
Backers' Associated Industries,
Box 1, Crane St. Station, Schenectady, N. Y.

BAKER, DAVID, JR., Metallurgical Engineer,
1011 Chestnut St., Philadelphia, Pa.
(American Representative,
Broken Hill Proprietary Co., Ltd., Australia.)

BARKER, L. B.,
General Electric Co., Bldg., 96
Schenectady, N. Y.

BARNINGHAM, CHAS. S., Sales Manager,
New England Butt Co.,
304 Pearl Street, Providence, R. I.

BARRETTA, SAMUEL,
John Roebling's Sons Co.,
Trenton, New Jersey.

BARTLETT, J. C., Proprietor,
Bartlett Hair Spring Wire Co.,
North Haven, Conn.

BASSETT, CYRUS W., Engineer,
Elevator Supplies Co., Inc.,
Rahway, N. J.

BASSETT, WILLIAM H., JR., Manager,
Metallurgical Development,
Anaconda Wire & Cable Co.,
Hastings-On-Hudson, N. Y.

BEACH, HAROLD K., Engineer,
Phelps Dodge Copper Products Corp.,
American Copper Products Division,
Elizabeth, N. J.

BEAMAN, P. ALDEN, Sales Manager,
Wire Machinery Department,
Morgan Construction Co.,
15 Belmont St., Worcester, Mass.

BEARD, READE M., Practice Supervisor,
Wire & Nail Mill,
Columbia Steel Co., Pittsburg, Calif.

BEARDSLEE, K. R., General Sales Manager,
Carboloy Company, Inc.,
11171 E. 8-Mile Road, Detroit, Mich.

BEESON, J. K., Asst. Gen. Mgr. of Sales,
Pittsburgh Steel Co.,
Grant Bldg., Pittsburgh, Pa.

BEIGHLEY, ANSON E., Sales Representative,
American Chemical Paint Co.,
2025 Mars Ave., Cleveland, Ohio.

BEKAERT, L. A., Managing Director,
S. A. Trefileries Leon Bekaert,
Sweveghem, Belgium.

BELLIS, A. P. S.,
John Roebling's Sons Co.,
Trenton, New Jersey.

BICKLE, E. H., Sales Mgr.,
Canadian Steel Corp., Ltd.,
Box 157, Walkerville, Ont., Canada.

BLACK, WINTON SLOAN,
Joint Managing Director,
Speedwell Wire Co., Ltd.,
Speedwell Works, Coatbridge, Scotland.

BLOOMBERGH, HOWARD A., President,
Nonotuck Mfg. Company,
Water Street, Holyoke, Mass.

BLOUNT, HARRY, Development Engineer,
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2500 Broening Highway, Baltimore, Md.

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(Please turn to Page 612)

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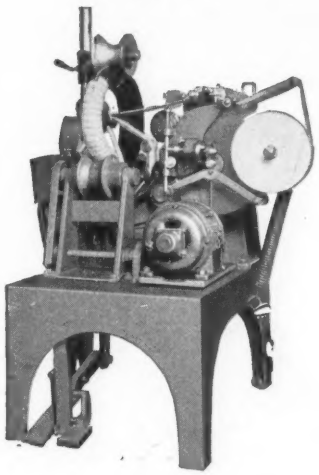

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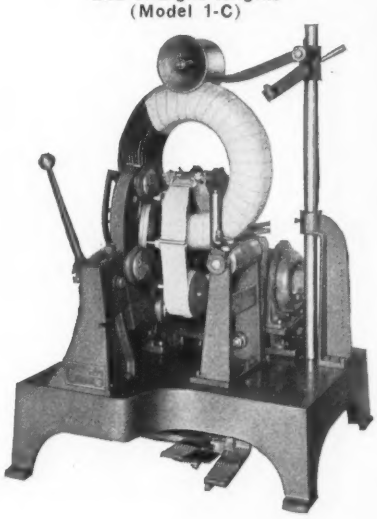
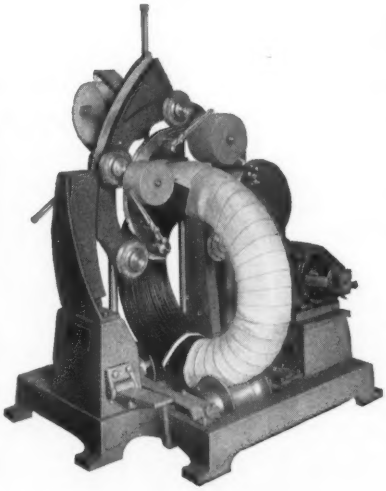


For wrapping of heavy type coils at floor level
(Model #4)



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BOONE, J., Gen. Foreman, Northwestern Steel & Wire Co., Sterling, Illinois.

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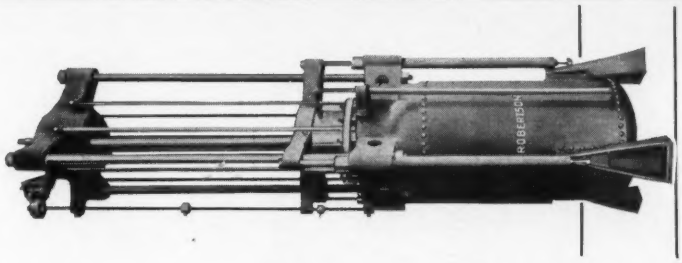

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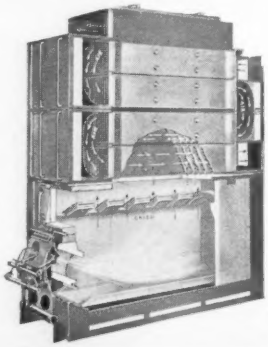

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FINDLEY, J. K., Metallurgist,
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National Machinery Co.,
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HALL, EDWARD P., Met.,
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JACKMAN, ALAN,
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JAGIELSKI, OTTO F., Designing Engineer,
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JEFFRIES, JAMES, Assistant Manager,
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Drawer Q, Shelton, Conn.

JENKS, FRANK, Production Superintendent,
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JOHNS, C. N., Vice Pres.,
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Sparrows Point, Md.

JOHNSON, F., General Manager,
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KENT, M. A., Vice Pres.,
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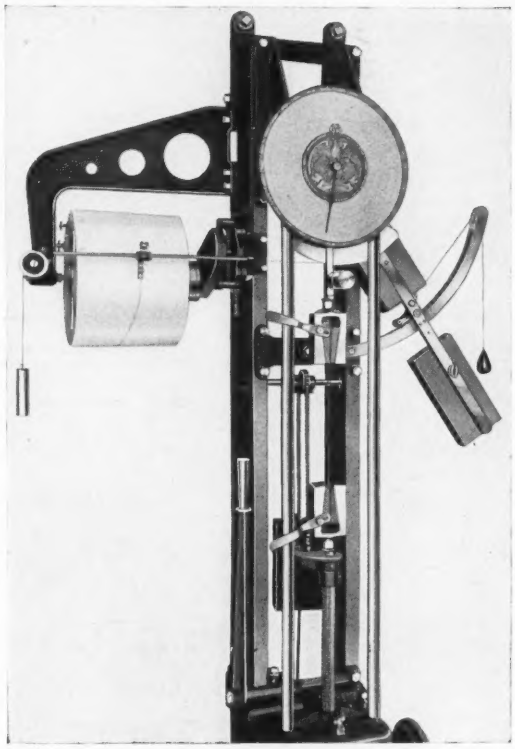

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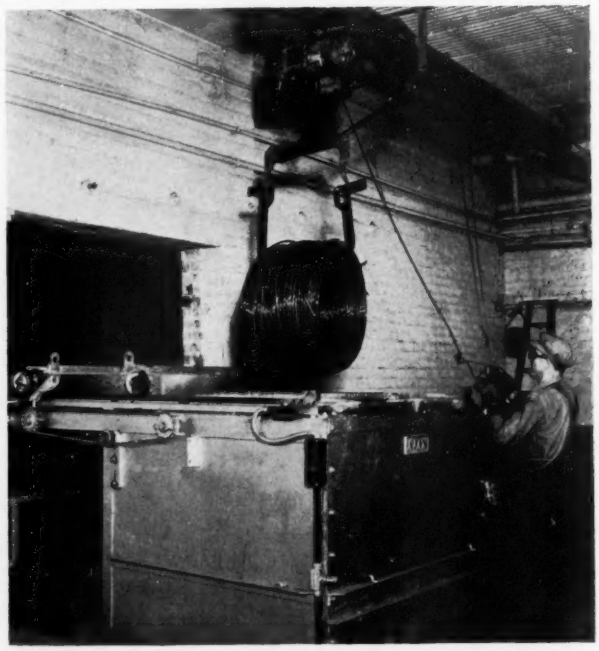

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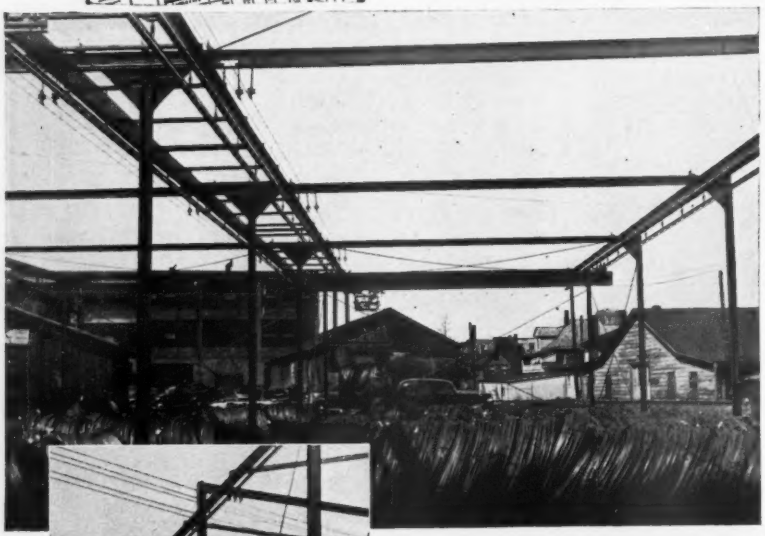
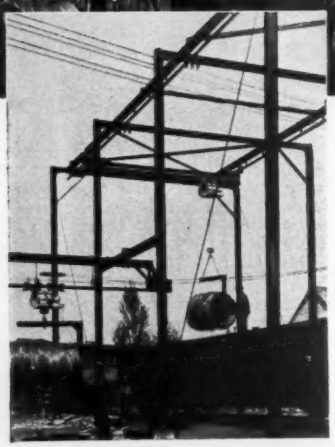
Kansas City, Mo.
WHEELER, G. CHAS., Vice Pres. & Wks. Mgr.,
Callite Tungsten Corp.,
540-39th St., Union City, N. J.
WHITNEY, LESLIE C., Chief Metallurgist,
Copperweld Steel Co.,
Glassport, Pa.
WHITTEN, J. L., Sales Mgr.,
Lee Wilson Engr. Co.,
1370 Blount St., Cleveland, Ohio.
WHYTE, R. B., General Superintendent,
Macwhyte Co., Kenosha, Wis.
WICKWIRE, CHESTER F., Vice President,
Wickwire Brothers,
189 S. Main St., Cortland, N. Y.
WIGGINS, C. R., Chief Metallurgist,
Northwestern Steel & Wire Co.,
Sterling, Ill.
WILCOX, RICHARD L., Vice President,
Waterbury Farrel Foundry & Machine Co.,
Waterbury, Conn.
WILEY, WILLIAM G., Asst. to Gen. Sales Mgr.,
General Cable Corp.,
420 Lexington Ave., New York, N. Y.
WILLIAMS, CHARLES G.,
John Roebling's Sons Co.,
Trenton, N. J.
WILLIAMS, JACK P.,
Syncro Machine Co.,
332 So. Michigan Ave., Chicago, Ill.
WILLIAMS, ROBERT C., Chief Chemist,
The Ironsides Company,
270 W. Mound St., Columbus, Ohio.
WILSON, FRANK B., Gen. Wks. Mgr.,
Guest, Keen & Nettlefolds, Ltd., Atlas Works,
Darlaston, S. Staffs., England.
WIND, WILLIAM J., Secretary,
Wilbur B. Driver Co.,
150 Riverside Ave., Newark, N. J.
WINKLER, L. H., Metallurgical Engineer,
Bethlehem Steel Co.,
Bethlehem, Pa.
WINTERSOHL, A. H., Superintendent,
Firthaloy Division, Firth-Sterling Steel Co.,
McKeesport, Pa.
WOOD, MAURICE L.,
Chase Brass & Copper, Inc.,
Waterbury, Conn.
WOODFORD, F. M., Western Manager,
Tungsten Electric Corp.,
2900 Euclid Ave., Cleveland, Ohio.
WOODHEAD, R. R., Research Engineer,
John A. Manning Paper Co., Inc.,
Troy, N. Y.
YOUNG, LAFE, General Superintendent,
Laclede Steel Co., Alton, Ill.
ZAPP, A. R., Manager Firthaloy Div.,
Firth-Sterling Steel Co.,
McKeesport, Pa.
ZARAFU, HERMAN, Plant Engineer,
Circle Wire & Cable Co.,
5500 Maspeth Ave., Maspeth, L. I., N. Y.
ZOUCK, JOHN, Chief Inspector,
Bethlehem Steel Co.,
Sparrows Point, Md.
ZUR, J. P., Metallurgical Engineer,
The Trauwood Company,
Cleveland, Ohio.

"Saves 32c per ton!"

in handling cost - - -





Unloading and storing coiled rod from box cars formerly cost 40c per ton and required 5500 sq. ft. of warehouse space.

Now, raw coils are unloaded from gondolas, stored outside and handled through pickling to punches and cold-headers at 8c per ton.

A Clear Saving of 32c per Ton Made Possible by Overhead Handling

Innovations, such as a turntable for transferring coils between hoists, develop in conference with American MonoRail engineers.

AMERICAN MONORAIL CO.

13117 ATHENS AVE., CLEVELAND, OHIO

'Round the World With the Wire Industry

European Notes

THE conditions in the wire industry in Europe have undergone drastic changes as a result of the war and a recent report from our foreign correspondent would indicate that British wire exports have more or less entirely stopped now that the Belgian source of wire rods is lacking.

✦ ✦ ✦

GERMANY, on the other hand, is again trading with Spain and Portugal and through these countries, doing some export business on a barter basis, shipping wire in exchange for non-ferrous metals, resin, turpentine, wolfram and tin ores, and quicksilver; in fact about the only wire exporter in Europe at present is Germany, as they are practically without competition now in the markets of the Scandinavian countries, Holland, Switzerland, Italy, Hungary, Roumania, Bulgaria, Greece and Yugoslavia.

✦ ✦ ✦

BECAUSE of the impossibility of getting Western supplies and also partially because of the new trade agreement made with Germany, Turkey, Iran and Afghanistan now get nearly 100% of their wire requirements from Germany.

✦ ✦ ✦

RECENTLY Portugese importers tried in vain to get tonnage orders placed for wire netting; Britain refused the orders, France, as long as the war lasts, is out of the running; and the Belgian wire industry, although partially recovered from the effects of the war, is still unable to sell for export.

✦ ✦ ✦

THE Belgian industry, however, has resumed selling to Switzerland and some nearby markets in moderate quantities and as soon as the workmen return from Southern France and Switzerland, where they have been driven by the war, it is expected that the Belgian industry will resume full operation.

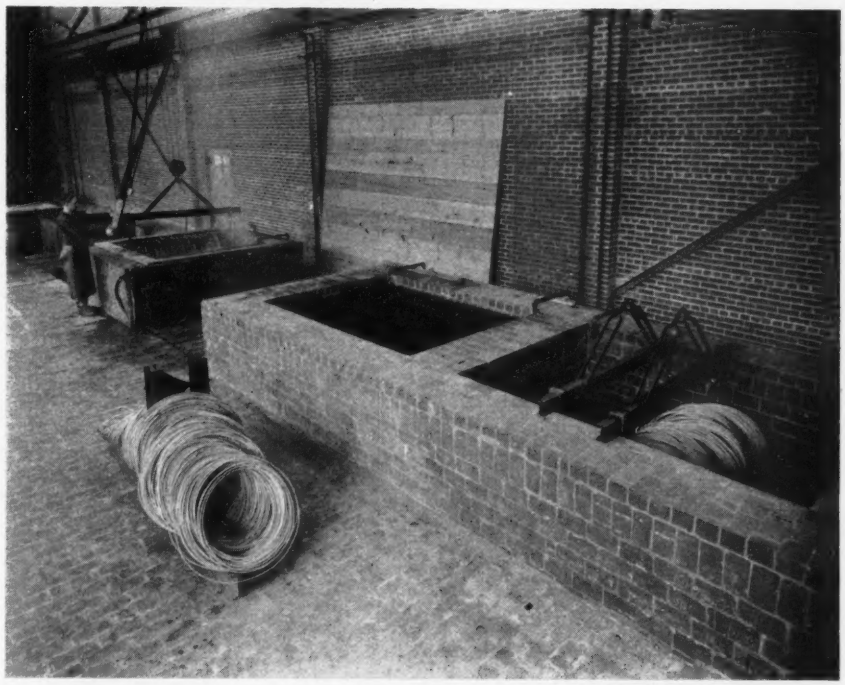
THE Austrian wire industry is working on export business to Russia, which is buying mainly high grade products such as wire ropes, high tensile strength steel wire, wire mesh, etc.

✦ ✦ ✦

WHILE Spain and Portugal are largely supplied by the German industry at present, there is some American competition. The local merchants say, however, that the American industry prefers to do business with Asia and Latin American countries and is not making very much effort at the present time to secure business in the Iberian market. The result is that Germany is able to secure

(*Please turn to Page 622*)

BASOLIT *Pickling Tanks*



Recently built in one of the largest steel mills in the East, the above installation for pickling stainless steel wire and rods consists of three tanks of our brick-lined reinforced concrete shell construction.

The tanks, separated by a wash rack, are provided with side outlets near the bottom and placed in an acid-proof, brick-lined pit. The tanks are operated with sulphuric, hydrochloric and nitric acid solutions at 185 deg. Fahr.

The above illustration is one of many hundreds where BASOLIT has contributed toward long life and efficient operation of modern pickling equipment.

Our Engineering Department will be pleased to furnish drawings and estimates without cost or any obligation on your part. Write us for special literature on pickling tanks.

NUKEM PRODUCTS CORP. Buffalo, N. Y.

New York Pittsburgh Steubenville, O. Detroit

'Round the World With the Wire Industry

(*Continued from Page 621*)

business on a basis of from six to eight weeks delivery with prices being more or less the same as domestic quotations, and with all business done in Reichsmarks. As a matter of fact, in the Iberian Peninsula the Reichmark is now the standard currency for trading with the remainder of Continental Europe. Prices (free German frontier) for wire nails are at about 160 marks; 185 marks for barbed wire, and for bright wire 150 marks, all per thousand kilos.

✦ ✦ ✦

IN France the German authorities have seized enormous stocks of wire which they have been selling for export. Recently about 4000 tons, mainly barbed wire and wire nails, were shipped to Spain, the Balkans and Turkey. From Germany proper no information is available as to the quantity export movement of wire.

Italian Program

THE Italian autarchic program calls for an annual production of 2,500,000 metric tons of crude steel. Productive facilities are believed adequate to this program and, in fact, virtually achieved this goal over the first six months of 1939 when 1,156,302 tons of steel was made (approximately 2,300,000 tons on an annual basis). The problem, therefore, is not one of facilities but of raw materials. It has been estimated that domestic sources of iron ore, pyrites, and scrap are normally sufficient to provide for the production of 1,000,000 tons of crude steel annually — some 40 percent of the program figure which, in turn, is held to represent Italy's normal peace-time requirement. The balance must be made up out of imports—of iron ore, scrap, and other iron and steel materials. During the first six months of 1939 Italian imports of scrap and of crude and semi-manufactured iron and steel totaled 508,889 tons with 392,796 tons of this total scrap. Ninety percent of these imports reached Italy via the sea and of these imports 90 percent were routed via Gibraltar. The effect of the closing of that Strait to Italian shipping upon the Italian steel industry is at once apparent—even though no account is taken of accumulated emergency stocks of iron and steel concerning which no data is available.

✦ ✦ ✦

Indian Output Up

PRODUCTION in British India was considerably higher in April, 1940 than it had been in April, 1939. The output of pig iron rose to 175,004 gross tons against 151,568 tons and that of iron castings amounted to 8,172 tons against 889 tons. Production of steel ingots totaled 85,702 tons against 75,842 tons with the output of finished steel reported at 69,398 tons against 57,150 tons. Production at the plant of the Tata Iron and Steel Company, Ltd., and at the Indian Iron and Steel Company, Ltd., rose but the Mysore Iron and Steel Works showed a slightly smaller total than in April, 1939.

You can roll up "reel" savings with

"American" Pressed-Steel Spools and Reels

We have all the tools, dies and modern equipment necessary to produce every type of spool and reel skillfully, quickly and economically. "American" Pressed-Steel Spools are used widely in the wire industry for production operations and shipping. They are light, clean and sturdy.

"American" Pressed-Steel Reels meet all the requirements of braiding, drawing, annealing, vulcanizing and shipping. The services of our Engineering Department are available, without obligation. Let us quote on your requirements.

THE AMERICAN PULLEY CO.
4200 Wissahickon Avenue,
Philadelphia, Pa.

Special Representative
WALTER A. RICHARDS
20 N. Wacker Drive,
Chicago, Ill.

Today's Metal Drawing Problems

A FOUR-PAGE folder enumerating the principal drawing and lubricating compounds produced by the **Fiske Bros. Refining Company,** Newark, New Jersey, is available under the above title.

✦ ✦ ✦

FOR seventy years this company has specialized in the manufacture of lubricants of various types and through complete laboratory research produce special lubricants for each purpose desired regardless of type or gauge of metal, depth of draw, or precision or speed required. In the folder they state that the company is prepared to render prompt cooperation to the trade through their Engineering Department, to satisfactorily solve such problems as present themselves.

✦ ✦ ✦

COPY of the booklet may be obtained by addressing Information Department, **WIRE & WIRE PRODUCTS.**

✦ ✦ ✦

Respirator Protection

AMERICAN OPTICAL COMPANY, Southbridge, Mass., announces another new filter cartridge for its versatile R-1000 respirator, thereby providing 5 interchangeable types of protection in one basic respirator.

✦ ✦ ✦

THE new filter gives comfortable protection against toxic dusts formed by crushing, grinding or abrading such solids as lead, cadmium, arsenic, chromium, manganese, selenium, vanadium and their compounds.

✦ ✦ ✦

THE other 4 filter cartridges announced previously by the optical concern provide protection against: (1) pneumoconiosis-producing dusts like quartz, asbestos, ores, coal, flour, etc.; (2) low concentrations of fumes, vapors or gases encountered in paint spraying, and other light organic vapors; (3) low concentrations of acid fumes and gases; (4) low concentrations of combined acid-organic gases and vapors.

Protection Against Dangerous Infections

THE **Magnus Chemical Company, Inc.,** has just issued a new descriptive, illustrated folder on its product, Magnus Skin-Gard.

✦ ✦ ✦

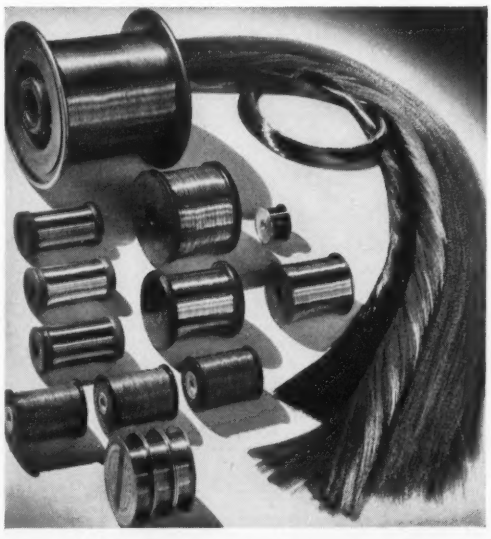
MAGNUS Skin-Gard is a cream, which when rubbed into the skin protects it against chemicals, solvents and dirt of all kinds—against dangerous infection, annoying cracks and abrasions. Workers whose skin comes in contact with solvents find Skin-Gard beneficial in preventing the solvents from removing the natural oils in the skin. The folder also discusses in detail the classifications and causes of industrial dermatitis and its prevention.

✦ ✦ ✦

A COPY of the Skin-Gard folder can be obtained by writing to the Magnus Chemical Company, Inc., Garwood, New Jersey.

STEPPING UP PRODUCTION

There's a reason why Callite has found it necessary to increase production space by another 100,000 square feet. It means that Callite's policies of dependability plus service are appealing to old customers and making new ones. It means too that users of base metal and special alloy wires now have the advantage of Callite's increased production facilities, with assurance of even speedier deliveries on standard and special wires.



The new Callite catalog will bring you full information on standard Callite wires and special wires to meet your precise needs. Included are a wide variety of metals, shapes, and sizes down to .001". If you have a special wire problem, consult Callite. Its staff of research and production engineers is at your service.

WRITE FOR COMPLETE DETAILS

Callite wires are available in Tungsten, Molybdenum, aluminum, steel, stainless steel, everdur, brass—all grades, brush wire, commercial bronze, fourdrinier, phosphor bronze, silver, nickel alloys and in combinations of these and other alloys. In round, flat and special shapes in sizes to .001".

CALLITE WIRES

CALLITE-TUNGSTEN CORPORATION

564-39th STREET • UNION CITY, N. J.

A WIRE FOR EVERY NEED

A Review of Recent Wire Patents

No. 2,210,663, HIGH-FREQUENCY CABLE, patented August 6, 1940 by Walter Max Hahnemann, Berlin-Marienfelde, Germany, assignor to C. Lorenz Aktiengesellschaft, Berlin Tempelhof, Germany, a company.

A high frequency cable having strap shaped conductors intersecting lengthwise at right angles wherein the conductors are slotted and one of them is made in two parts assembled in the slots of the other conductor.

✦ ✦ ✦

No. 2,211,392, WIRE DRAWING MACHINE, patented August 13, 1940 by Clarence L. Taylor, Youngstown, Ohio, assignor to The Aetna-Standard Engineering Company, Youngstown, Ohio, a corporation of Ohio.

A hollow block is provided, having a portion on which the wire is wound after it is drawn through a die of the machine, means for rotating the block, means for directing a stream of cooling fluid against the inner surface of the block and a water box for carrying away the water discharged against the inner surface of the block, the water box having a channel disposed adjacent the base of the block, the cross-sectional area of the channel gradually increasing in the direction of discharge of the water and in the direction of rotation of the drum.

Complete Descriptions and Drawings of Patents May Be Had for 25 cents. Address, Wire & Wire Products, 300 Main St., Stamford, Conn.

No. 2,211,415, POTASSIUM-SODIUM-LEAD ALLOY, patented August 13, 1940 by Harvey N. Gilbert, Niagara Falls, N. Y., assignor to E. I. du Pont de Nemours & Company, Wilmington, Delaware, a corporation of Delaware.

The alloy is described as being highly resistant to crushing and breaking, and which reacts non-violently with water, containing not less than 83% by weight, of lead, and in which the weight ratio of potassium to sodium is about 3.0 to 1.

✦ ✦ ✦

No. 2,211,925, SPRING INSERT FOR SPRING ASSEMBLIES, patented August 20, 1940 by William W. Gleason, Chicago, Illinois, assignor to Nachman Springfilled Corporation, Chicago, Illinois, a corporation of Illinois.

An M-shaped spring insert is provided, of flat strip metal of a width less than the diameter of the helical border springs, the side arms of the insert being partly sinuous and with convex faces projecting into the spaces between coils of the border springs.

No. 2,212,132, METHOD OF AND APPARATUS FOR FORMING CABLES, patented August 20, 1940 by Walter B. Shear, Newark, N. J., assignor to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York.

Specifically, the invention covers a method C apparatus for compressing covered electric cables into predetermined shapes.

✦ ✦ ✦

No. 2,212,180, METHOD OF PACKAGING COILS FOR SHIPMENT AND PACKAGE STRUCTURE, patented August 20, 1940 by Alphonsus F. Murphy, Zanesville, Ohio, assignor to the American Rolling Mill Company, Middletown, Ohio, a corporation of Ohio.

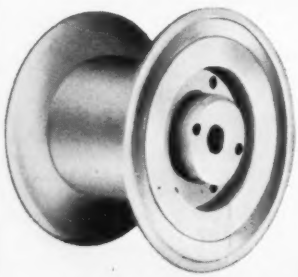
More specifically the invention relates to a process and device for packaging heavy coils of sheet metal.

✦ ✦ ✦

No. 2,212,243, STRIP COILER, patented August 20, 1940 by George F. Paul, Struthers, Ohio.

A device is provided to guide the leading end of the metal strip about the mandrel and prevent the strip from departing from its proper course while the first turn of the coil is being made.

FINE WIRE HIGH SPEED WIRE DRAWING SPOOLS



James Day (Machinery) Ltd.,
66, Bartholomew Close,
London, E. C. 1., England.

MOSSBERG **PRESSED STEEL** CORP.

A complete line of HEAVY DUTY PRECISION SPOOLS and REELS especially designed for high speed wire drawing and annealing.

The degree of efficiency obtained by the HIGH SPEED WIRE DRAWING MACHINE is largely dependent upon the accuracy and durability of the take-up spool.

The use of our PRECISION SPOOLS will increase your machine efficiency and eliminate your spool difficulties.

Complete range of sizes.

MOSSBERG PRESSED STEEL CORP

18 West Street,
ATTLEBORO, MASSACHUSETTS, U. S. A.

COMBINATION
500 lb. CAPACITY WIRE DRAWING — ANNEALING — STRANDING — REEL.

No. 2,212,360, ELECTRICAL CABLE, patented August 20, 1940 by James Nelson Aken, Rome, New York, assignor to General Cable Corporation, New York, N. Y., a corporation of New Jersey.

For house wiring, this cable has a non-metallic sheath, presenting a straight smooth exterior appearance, yet will have good flexibility.

✦ ✦ ✦

No. 2,212,787, NONSPLIT NAIL, patented August 27, 1940 by Malcolm E. Miller, Columbus, Ohio.

This nail is formed with wedge-shaped grooves at the point tapering from a small entrance end to a wide rear end on the shank of the nail, the grooves having flat bottom walls, the inner diverging side walls of the grooves terminating in rounded ends which merge with the surface of the shank, the wedge-shaped contour of the grooves permitting the wood or other material, into which the nail is driven, to expand in the wide end of the grooves and prevent splitting of the material.

✦ ✦ ✦

No. 2,212,796, WIRE FABRIC, patented August 27, 1940 by Karl Schuster, Giengen-on-the-Brenz, Germany, assignor to F. Oberdorfer G. m. b. H., Heidenheim-on-the-Brenz, Germany, a joint-stock company of Germany.

More specifically, the invention relates to a method of joining wire fabric, and comprises cutting the pieces of fabric in agreement with each other obliquely to their longitudinal or transverse direction, deflecting the ends of the wires of at least one of the pieces of fabric along the line of cut out of the plane of the fabric, fitting the wires together so that the wires of the one piece of fabric abut against the wires of the other piece, and thereupon joining the said wires by welding them together.

✦ ✦ ✦

No. 2,212,927, LEAD COVERED MULTICONDUCTOR ELECTRIC TELEPHONE CABLE, patented August 27, 1940 by Eric Baguley, London, England, assignor to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York.

Conductors of the outer layer cores are spaced further apart from one another than the conductors of the inner layer cores. In this manner, the alternating current resistance and self inductance of the circuits formed by conductors in the outer layer may be made about the same as of the circuits formed by the conductors of the inner layers.

✦ ✦ ✦

Standard Round Hole Dies for Bar and Tubing Up to 3½"

AVAILABILITY of standard round hole dies for drawing sizes of bar and tubing up to 3½ in. diameter, and improvements in construction in the larger series—R7 to R16—of standard drawing dies, are announced by **Carboloy Co., Inc.**, Detroit.

✦ ✦ ✦

TENDENCY to use cemented carbide dies for larger sizes of bars and tubing has led to the introduction of the R-18 type as a standard die. Nib dimensions of the die are 5.50 in. diameter by 2.125 in. in height, with a casing dimension of 9 by 3¾ in. It is designed for drawing work ranging from 2¾ to 3½ in. diameter.

✦ ✦ ✦

IN addition, 'cored' dies previously available only in the smaller —R1 to R6—series, are now also available in the series R7 through R10, for drawing fractional sizes of bar and tubing from 3/16 to ¾ inch in size. Rough drilled dies, available previously in these sizes —in addition to finished dies—are continued.

✦ ✦ ✦

PRINCIPAL improvement in the larger series of dies, from the R-10 through the R-16, is a material increase in the size of the nib, to provide a longer bearing for easier push start bar-drawing and tube-sinking. Increases in height for the various dies range from 1/16 to ⅜ in.

"NEP"

AND

SUM-FOAM

The most extensively used

INHIBITORS

in

AMERICA

Especially designed for Rod and Wire Mills for:-

LOWER COSTS
CLEANER FINISH
LARGER TONNAGE

Successfully serving the Steel Industry for 27 years

THE WILLIAM M. PARKIN COMPANY

Chemical Engineers to Steel
PITTSBURGH, PENNA.
Write for latest Bulletins today!

1940 Developments in the Wire & Cable Industry

(*Continued from Page 602*)

proof finishes eliminated. These are replacing rubber insulations in some types of cable and wire and, because of reduced diameters over insulation, larger conductors can be used in the same duct space.

✦ ✦ ✦

VARNISHED cambric insulated conductors can now be operated at higher temperatures because of new varnishes and improved methods of cloth treating.

✦ ✦ ✦

A GREAT deal of attention has been given to improving materials and methods in the manufacture of high-voltage paper-insulated cables. Special methods of treating the oils used in impregnating paper insulation have been developed. All impurities are removed including moisture, air, or gas, which may have been absorbed in the oil.

IN the past, some failures in paper-insulated cables have been due to faulty lead coverings. A great deal of time and money have been expended by manufacturers to correct this condition by improving the melting, pouring, and extrusion methods used in the process of encasing cables with a lead sheath. It is now possible to encase cables with a lead sheath of uniform thickness, absolutely free from oxide and imperfect welds, for the entire length of the cable.

✦ ✦ ✦

ALL developmental changes in design and construction of high-voltage cable are expensive. Many test lengths must be manufactured and exhaustive tests made on them. These tests must be carried on for long periods and usually to ultimate destruction of cable.

✦ ✦ ✦

ONE outstanding development completed in the past year in paper insulated cables is the gas-filled type which is being operated successfully. Another development is the use of carbon-treated papers as insulation.

✦ ✦ ✦

IMPROVEMENTS in methods of paper tape application and oil impregnation have resulted in lower power factors and higher insulating qualities.

✦ ✦ ✦

THE purchaser today receives for his dollar a better cable with a longer life expectancy than ever before. He can feel assured that future requirements will be met with even better cable because of the research and development that is being continually carried on by the cable manufacturers.

✦ ✦ ✦

Oil Impregnated Twisted Paper Twine

E. W. TWITCHELL INCORPORATED, of Philadelphia, Pa., announces the introduction of an oil impregnated twisted paper twine to replace jute or cotton as a filler in the interstices of two or more wire cable jobs for various purposes.

Hubbard Spool Company

Extends Greetings to the Members of the

Wire Association

Hubbard Spool Company

1622 Carroll Avenue Chicago, Ill.

TELEPHONE SEELEY 1214

In presenting this material, Mr. Chatterton states: "This twisted paper twine has been developed for use as a filler in the Non-Metallic Sheathed Cable wire especially where three wires are used. Naturally on the two wire job a rip cord is necessary and paper twine does not have the necessary strength for this purpose, but as a filler cord it replaces jute or cotton. It is admirable in that it will lend itself to most any type of oil or waterproofing agent that might be required. Also it is an American product made by American people throughout and it is obtainable in time of war as well as in peace."

✦ ✦ ✦

Electric Coil Bobbin

A NEW type of electric coil bobbin has been developed by the **Precision Paper Tube Company,** Chicago, Illinois, that enables manufacturers of small motors, relays, solenoids, reactors, photo electric devices and other electrically actuated equipment to use the smaller and more efficient bobbin coil rather than the larger layer wound coil, having an insulating strip between each winding layer and popularized by its low cost.

✦ ✦ ✦

THESE new bobbins are made of either Kraft or Fish paper, or a combination of both, depending on the requirements. The paper is spirally wound on a steel die on automatic machines to form a tube of convenient length, which is cut into proper bobbin sizes. The flanges are of vulcanized fibre, die cut to the exact size and shape and pressed over the ends of the tubes. The ends of the tubes are swaged, locking the flanges in place. Impregnating the bobbin with a special lacquer increases its strength and forms a seal between the tube and flange and improves electrical characteristics. Round, square or rectangular bobbins of any size can be made with the same degree of accuracy.

IT is claimed that due to extreme exactness in manufacture unusually close tolerances can be maintained. This is an important factor in the winding and assembling of the coil into the finished product.

✦ ✦ ✦

IN addition to the saving of space, bobbin coils of this construction overcome the heat factor problem as they permit the use of a larger guage wire in the same amount of space.

DUE to the materials used and the method of construction the manufacturer states that the low cost of these bobbins now permits the use of bobbin wound coils instead of layer wound at no increase in manufacturing cost.

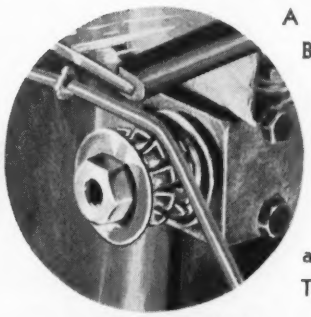
✦ ✦ ✦

COMPLETE information, literature and samples of these new bobbins can be obtained by addressing — Information Department, **Wire & Wire Products,** 300 Main St., Stamford, Conn.

AMES BUTT WELDER

IB

INTRODUCING
TO THE
WIRE TRADE



BURR REMOVER
PATENTED

A Combination Butt Welder Cutter and Burr Remover with new and distinct Time Saving Features.

Perfecting the art of removing the burrs from welded wire rods with new burr removing device. Cutters, that furnish clean cut rivet ends for stronger welds, all conveniently located and heat control on top of welder.

A sturdy, well built, and compact machine for Wire Mills where speed, control, and ease of operation is essential.

Carefully engineered and performance proven. Protected by American & Canadian Patents.

IGOE BROTHERS, INC.

AVE. A. & POINIER STREET NEWARK, N. J.

Electromatic Oil Tempered Spring Wire

A NEW product, Electromatic Oil Tempered Spring Wire, for special mechanical springs is now being produced by an electric direct resistance method by the Jones & Laughlin Steel Corporation, Pittsburgh.

✦ ✦ ✦

IN contrast to the conventional methods of heating wire to quenching temperatures, either in furnaces or by immersion in molten baths, this new process consists of passing sufficient electric current through the wire to heat it to the desired temperature, much as the coils in an electric toaster are heated by their resistance to the current. The electrical resistance set up in the wire increases its temperature uniformly, and the full cross section of the wire is heated simultaneously to the desired quenching temperature.

✦ ✦ ✦

THE new equipment handles a wide variety of gauges, and is so constructed that wire fed from reels passes first through tension rollers then through a molten electrical contact. From there, the wire passes through a second molten contact, completing the electric circuit through the wire. These contacts are held at a constant predetermined temperature, the second also serving as a prim-

ary quenching bath from where the wire immediately passes to an oil bath for the final quench. This double-phase quenching feature provides a gradual reduction in wire temperature, preventing the steel from being shocked by a sudden great drop in temperature. Continuing from the final quench through a molten tempering bath, the wire is reheated to give it the desired physical properties and fatigue values. It may then be passed through a light soluble oil bath prior to shipment.

✦ ✦ ✦

THE increasing demand for higher and more uniform physical properties in spring wire is largely responsible for the development of this process, its fundamental advantage being the exactness by which all factors affecting the ultimate quality of the wire are readily controlled. The constant flow of electric current of controlled voltage and amperage fed into the wire, together with the closely regulated speed of the machines, governs heating the wire to within very exact limits. In addition, thermocouples in all contact, quench, and temper baths provide automatic temperature control over these units. The resulting combination of accurate time and temperature regulation makes possible precise control of the heating and quenching cycle.

✦ ✦ ✦

AS length of heating time and control of quenching tempera-

STANDARD OR SPECIAL DESIGN MACHINES AND EQUIPMENT

FOR

WIRE, ROD OR STRIP MILL

Strip Coilers — Cold Rolling Equipment — Rod Coilers
Galvanizing and Tinning Equipment — Scrap Bundling Machines
Wire Drawing Machines - - Continuous and for Fine Wire

Cotter Pin, Edging, Straightening and Cutting Machines
Cleaning and Pickling Equipment — Pointers — Swagers — Wire Frames
Wire Puller Tongs

High Grade Equipment at Present Day Prices — Your Inquiries Invited

BRODEN CONSTRUCTION CO.

ENGINEERS - - BUILDERS

Wire Mill and Cold Rolling Equipment

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tures have a direct effect on grain structure, this method makes it possible to control and reproduce desired grain sizes with the utmost accuracy. The double-phase quenching provided has been found to considerably improve the physical characteristics of the wire, and makes possible a close control of tensile strength, elastic limit, elongation, and Rockwell values. Also, as all the heat is within the wire itself, decarburization and scaling is controlled to narrow limits, not possible in processes using indirect heating.

✦ ✦ ✦

APPLICATIONS of this spring wire are to be found in widely diversified industries. Brake springs, clutch springs, grid seat springs for automobiles, various similar applications in the airplane construction industry, and mechanical springs for machinery used on farms, in mills and factories, and other industries are among the uses for this new type of wire.

✦ ✦ ✦

New Bulletin for Metal Working And Finishing Industry

A NEW bulletin for the Metal Working and Finishing Industry has just been issued by the Magnus Chemical Company, Inc., Garwood, N. J., manufacturers of industrial cleaning materials and metal working lubricants. The bulletin consists of a series of detailed performance reports from metal working plants of all kinds, outlining improvements and economies effected by the use of properly selected cleaning materials in comparison with formerly used materials and methods.

✦ ✦ ✦

FOR convenience, these reports are arranged in a number of classifications, each involving a particular metal cleaning and finishing operation.

✦ ✦ ✦

THE reports are full of usable and practical ideas that will help you save money, speed production and meet rigid quality specifications.

✦ ✦ ✦

FOR copy of this bulletin address Information Department, **Wire & Wire Products.**

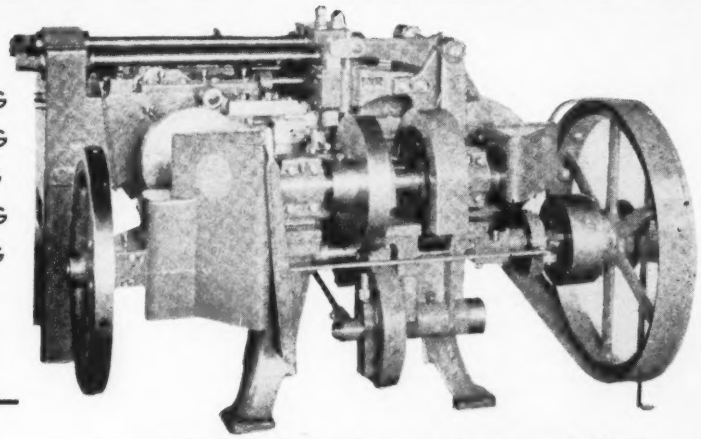
Milton P. Higgins, Asst. Mgr., Abrasive Production & Research, The Norton Company

MILTON P. HIGGINS, resident manager of the Norton electric furnace plant at Chippawa, Ontario, for the past two years, has been transferred to the Worcester headquarters as Assistant Manager of Abrasive Production and Research. Mr. Higgins has been with the Norton Company for about 12 years. Previous to the Chippawa post, he was manager of sales research at Worcester and in special sales work in the Chicago territory. He is a director of Norton Company and also of their Behr-Manning division.

NILSON

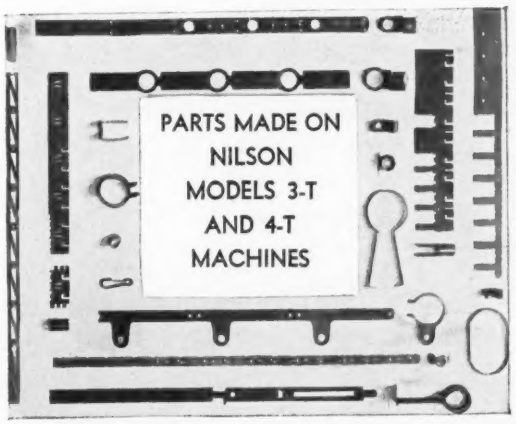
AUTOMATIC PRESS AND FOUR SLIDE MACHINE

FOR SWAGING STAMPING PIERCING BLANKING FORMING OF COILED METAL



A General Purpose, Heavy Duty Fabricating and Metal Forming Machine.

WE Build machines for forming Paper Clips, Buckles, Gate Hooks, Coat and Hat Hooks, Ceiling Hooks, Wire Ears, Cable Rings, Screw Eyes, Sash Chains, Automobile Side Chains, Flat Open Link Chains, Staples, Cotter Pins, Hose Clamps, Etc. and Wire Straighteners, Wire Reels, Frame Bending Machines and Special Presses.



▲▲▲

For Complete Details Address —

THE A. H. NILSON MACHINE CO.

BRIDGEPORT, CONN., U. S. A.

For BETTER WIRE

Copper-coat with CUPRODINE

CUPRODINE creates a denser, tighter, brighter and more uniform coating, in less time. Provides better lubrication for drawing than ordinary copper coating.

Pickle with RODINE

CHEMICALS ACP PROCESSES

RODINE, added to the pickling bath, saves acid and metal, minimizes brittleness, and lowers pickling costs. Standard the world around.

For complete information write Dept. 306

AMERICAN CHEMICAL PAINT CO.
Main Office and Works Ambler, Pennsylvania
Detroit, 6339 Palmer Ave., E.
Canadian Branch, Walkerville, Ont.

Strength!

Clark Cable and Insulated Wire Spools provide strength and rigidity for the most difficult wire and solder winding operations.

This rugged construction is easy to assemble, reducing over-all costs of operation. A simple hand arbor, foot, or power press operation permanently assembles heads and barrels. All parts are lithographed for identification purposes and to protect the metal.

SPECIFICATIONS

HEAD DIAMETERS —5, 6½", and 10½"
BARREL DIAMETERS—1 15/16", and 3½" (special diameter for 10½" head)
BARREL LENGTHS —To meet your capacity needs

J. L. CLARK MANUFACTURING CO.
600 23rd Avenue Rockford, Illinois

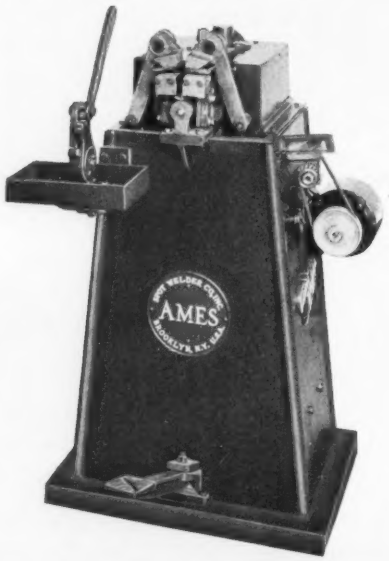
New Butt Welder Announced by Igoe Bros., Inc.

A NEW welder especially developed for the wire trade has been developed by the combined efforts of **Igoe Brothers, Inc., Newark, N. J.,** wire manufacturers, and **Ames Spot Welding Co., Inc., Brooklyn, N. Y.,** manufacturers of welders.

✦ ✦ ✦

THIS welder having been developed in a Wire Mill carries with it all the essentials necessary to assure ease and low cost of operation so essential to wire production.

✦ ✦ ✦



IGOE BROTHERS, INC. operating their own Wire Mill saw the necessity of a welder especially adapted to the wire trade. **The Ames Spot Welding Co., Inc.,** manufacturers of electric welding machines was called in to engineer such a machine. The results of the combined efforts of the two companies is a machine, sturdy in construction so as to insure continuous operation on a twenty-four hour basis, engineered to operate at the lowest possible power consumption, and has all electric parts completely enclosed in the base, thus safe-guarding them from foreign matter.

✦ ✦ ✦

THE power control knob and indicator is conveniently located

on the top of the base. The welding dies are made of **Mallory** metal to assure long life and are mechanically operated to eliminate the human element, and assures uniform performance.

✦ ✦ ✦

THE machine also has embodied in it a pair of rotary cutters which assures a square cut end, and a special tool steel rotary burr remover which also assures long life, ease of operation, and the rapid removal of the burr after the rod or wire has been welded.

✦ ✦ ✦

THE machine is so designed that all operations are conveniently located so that the operator can complete all three with a single step. In actual performance it has been found that this welder will produce sound welds from 90% rod ends not rimmed, thus saving rod, and that a range of from 10 gauge wire to ⅜ rod is being welded on the same machine, likewise a wide carbon range can be handled.

✦ ✦ ✦

IGOE BROTHERS, Inc. have also developed, patented, and proven, a Slip Ring for double deck blocks which they now offer to the trade, and which has the following advantages:

Prevents scratched wire caused by slipping over solid rings.

Prevents breakage of wire between the drafts by the tension being automatically controlled.

Helps prevent dies wearing oval, thus longer life, less die waste, shorter redressing time.

Reduces ring wear by 50% or more, thus greater operating time of block.

Reduces time required for changing rings for redressing to a fraction of the time required to change the solid rings, as the block is not removed, full and complete details of which will be announced in this publication at an early date.

Manufacturers of materials, tools and equipment for wire drawing and forming plants are constantly making improvements and additions to their lines. If you do not find the product or service in which you are interested, additional information will be supplied promptly. Simply address:

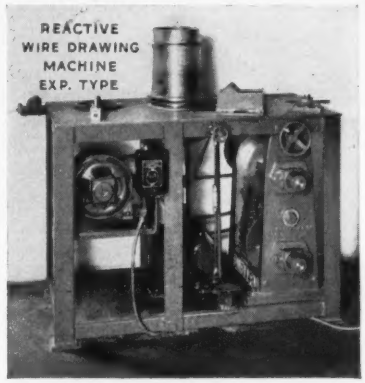
WIRE & WIRE PRODUCTS
300 Main St. Stamford, Conn.

SINGLE HOLE AND CONTINUOUS PRODUCTION MACHINES

MORE WIRE and BETTER WIRE---At Less Cost

Less Power Per Ton

Lower Die Costs



More Production

Lower Costs Per Ton

(Manufactured and sold under Smith-Stringfellow Patents)

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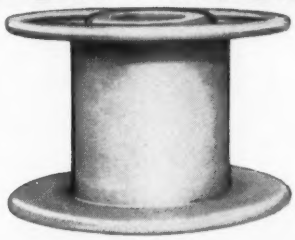
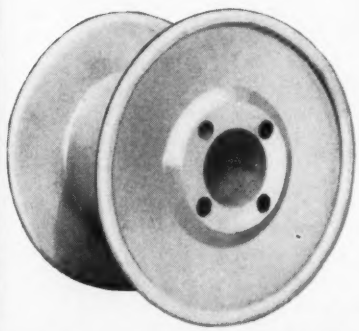
REACTIVE WIRE DRAWING
Room #36, Central Exchange Bldg., Worcester, Mass.

FOR HIGHEST SPEEDS





APCO MOSSBERG
PRECISION
STEEL REELS

The reels that are engineered to the job... designed and built by the company that originated the steel reel idea . . . are the reels you should be using in your plant. Every year, more and more Apco Mossberg Steel Reels are bought by quality-minded buyers throughout the wire industry.

FREE
ENGINEERING SERVICE

Without obligation to you, Apco Mossberg engineers will be glad to study your reel problem, and supply complete suggestions, drawings, blue prints. Write for information today.

REELS..SPOOLS..BOBBINS

APCO MOSSBERG COMPANY
(THE ORIGINAL FRANK MOSSBERG CO.)
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If You Want:

Better Temperature Control . . . More Uniform Product
Better Physical Properties . . . . Less Equipment Investment
Lower Operating Cost . . . . . Lower Maintenance Cost
Less Floor Space . . . . . No Dirt or Smoke

Use Bellis Lavite Furnace

made and sold by

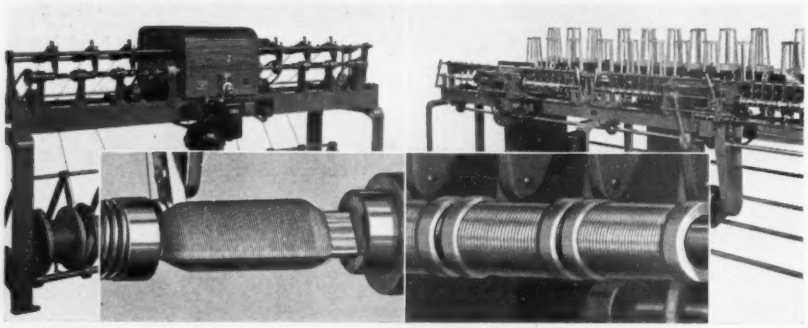
The BELLIS HEAT TREATING COMPANY

Branford, Connecticut

Having these exclusive features:

* Heating by current through the bath between pot wall and adjustable electrodes.
* Pots and electrodes immune to chemical attack and resistant to oxidizing.
* Neutral baths of low melting point and wide temperature range.
* Wrought non-porous alloy and steel pots.
* Non-Hygroscopic baths that descale and absorb oxides.
* Triple Furnaces with baths mixing at all heats.
* Electrodes water-cooled through the furnace wall.
* Permanent or portable starting coils.
* Patented.

WIRE SPOOLING MACHINES



On Sticks or Spools . . . from Reels or Coils

Typical of FIDELITY Spooling Machines that you find serving every spooling-operation need of wire industry, these two new types command attention to advanced achievements in precision winding of the wire onto little flat sticks or conventional spools, at new high production rates and new low spooling cost.

You'll be interested especially in the new FIDELITY hydraulic control which eliminates gear changes . . . so write for Bulletin #61.

WIRE SPOOLING, TAPING, WINDING, SINFRA KNITTING, BRAIDING MACHINES

FIDELITY MACHINE COMPANY

3908-18 FRANKFORD AVENUE, PHILADELPHIA, PA.

The Endurance Properties of Hard Drawn Wire from Various Kinds of Copper

(*Continued from Page 593*)

THE endurance tests were performed on copper that had been hot rolled to a 5/16 in diameter rod; it was then drawn to an 0.080 inch diameter. In order to secure uniformity in treatment and workmanship, all of the samples were fabricated by one concern. Sixty inch straight lengths of wire, made from the following kinds of copper wire bars were used for the investigation:

Lab. # 1790 Oxygen free high conductivity copper, vertical cast
1791 Oxygen free high conductivity copper, vertical cast
1792 Tough pitch copper, vertical cast
1794 Regular tough pitch copper
1795 Regular tough pitch "Lake" copper
1796 Regular tough pitch "Chile" copper

✦ ✦ ✦

Tentative Results

1) **In general, the endurance limits, appear to be relatively proportional to the cold reverse bend values. The materials which withstood the greatest number of cold right angle reverse bends, show a trend toward higher endurance limits.**
2) **The oxygen free coppers and the vertical cast copper appear to have the higher endurance limits.**
3) **Microscopic examination indicates that there is a tendency for the fatigue crack to start on the side of the wire with the greatest surface irregularity.**
4) **Conclusion #3 appears to be borne out by the good results obtained on vertical cast tough pitch copper; it is not confirmed by the relatively poor showing exhibited by wire made from scalped wire bars.**
5) **No conclusive data have been obtained on corrosion-fatigue but the preliminary tests indicate that interesting results may be expected.**

Manufacturers of materials, tools and equipment for wire drawing and forming plants are constantly making improvements and additions to their lines. If you do not find the product or service in which you are interested, additional information will be supplied promptly. Simply address:

WIRE & WIRE PRODUCTS
Stamford Trust Co. Bldg.,
300 Main St. Stamford, Conn.

Federal Specifications Approved And Available

THE following Federal specifications have now been approved for use in government purchasing. The date after each title shows when the specification becomes effective.

Lamps; electric, incandescent, minature, tungsten-filament. Amendment-2 W-L-111b Sept. 1, 1940.

Wire; bale-tie, single-loop. (new) QQ-W-311 Sept. 1, 1940.

Wire; steel, zinc-coated (for wire-bound boxes). (new) QQ-W-446 Sept. 1, 1940.

✦ ✦ ✦

ANYONE wishing to order copies of these specifications and amendments may do so from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is five cents each.

✦ ✦ ✦

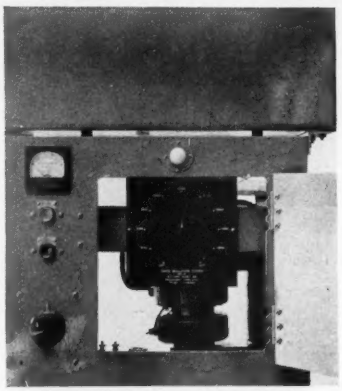
Price Reductions Announced on Tungsten Carbide Dies and Tools

INCEPTION of the expanded manufacturing program and economies resulting from greater production efficiencies in **Carboloy's** new million-dollar plant has made possible, according to **W. G. Robbins,** Carboloy president, a further price reduction—the sixth since 1929—on cemented carbide metals, thereby also effecting price reductions on other Carboloy products, including special tools and tool bits, dies, wear resisting inserts, etc.

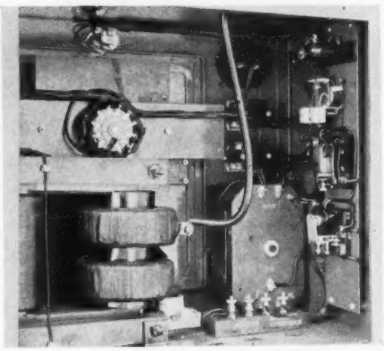
✦ ✦ ✦

FIRTH-STERLING STEEL COMPANY has issued to the trade a price reduction, effective as of September 3, on the company's sintered carbide tools and dies. The announcement states that, in many instances, the new carbide prices make it possible to manufacture or purchase carbide tipped tools at costs approximating those of solid high speed steel tools.

For Information
Regarding
The Wire Association
Address
Richard E. Brown, Secretary
Stamford Trust Co. Bldg.
300 Main St. Stamford, Conn.



Front View (Shows Door Open)

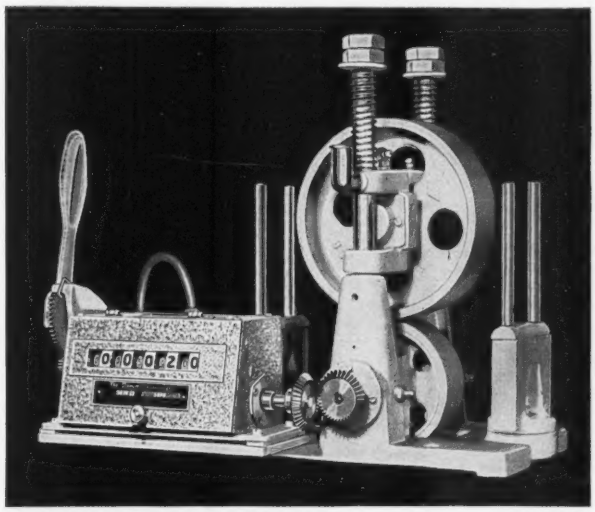


Interior View

Sparker for Continuous Cure and Synthetic Extrusions Compounds

THIS APPARATUS WILL LOCATE DIELECTRIC FAULTS WHILE THE WIRE IS BEING INSULATED. WHEN BREAKDOWN OCCURS, THE OPERATOR IS NOTIFIED BY AN AUDIBLE ALARM. A TOTALIZING AND RESETTABLE COUNTER GIVES THE NUMBER OF FAULTS IN EACH REEL AND TOTAL FAULTS PER DAY. BY SORTING OUT THE DEFECTIVE REELS IN THIS OPERATION, THE MAJORITY OF THE RESPARKING IS ELIMINATED. CONTINUOUS RANGE OF VOLTAGE AT THE ELECTRODE IS FROM TWO THOUSAND TO SIXTEEN THOUSAND KILOVOLTS. THE SPARKER IS EQUIPPED WITH VOLTMETER READING IN KILOVOLTS, PUSH BUTTON CONTROL AND AUTOMATIC INTERLOCK WITH THE TAKEUP MOTOR.

R. L. Davis Electric Co.
Wallingford, Conn.



Now a

Wire Measuring Machine for Every Purpose

The recent addition of several new models enables us to offer wire and cable manufacturers and users, machines for the fast, accurate lineal measurement of any kind of bare and insulated wire, twisted pairs, wire rope and lead-covered or armored cable. Capacities .005" dia. and up.

Write for bulletin giving description and prices of Productimeter Wire Measuring Machines and Braiding Machine Counters.

DURANT MFG. CO.
1918 N. Buffum Street
Milwaukee, Wisconsin
176 Eddy Street
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ALL STEEL REELS

FOR SHIPPING
FOR STORING
CABLE AND WIRE

Last Longer

Constructed of corrosion resisting materials, three to four times the life of a wooden reel is a reasonable expectancy.

Give Greater Protection

Smooth inner surfaces, much greater strength with the absence of all cutting or abrading projections — these protect not only the cable but the men handling it.

Save On Freight

Appreciably lighter than wooden reels — cost less to ship — a cumulative saving that more than offsets increased first cost.

Reduce Investment

The longer life of R. B. Hayward Steel reels reduces the investment in reel equipment.

Write for description of construction and prices.

R. B. HAYWARD CO.

1714 Sheffield Ave.

Chicago, Illinois

Exports and Imports

(*Continued from Page 597*)

gross valued at $245; Republic of Panama, 1,675 gross valued at $343; Ecuador, 1,271 gross valued at $201; and Egypt, 1,073 gross valued at $728.

✦ ✦ ✦

EXPORTS of brass wood screws during the same period totaled 19,572 gross valued at $14,117. Of this total the United Kingdom took 5,000 gross valued at $8,537; The Philippine Islands, 2,500 gross valued at $643; Cuba, 2,100 gross valued at $684; British India, 1,960 gross valued at $826; New Zealand, 1,930 gross valued at $743; Venezuela, 1,821 gross valued at $751; Iceland, 893 gross valued at $265; Mexico, 659 gross valued at $243; Netherlands Indies, 474 gross valued at $271; Other British West Indies, 462 gross valued at $169; Peru, 339 gross valued at $96; Republic of Panama, 337 gross valued at $134; Argentina, 285 gross valued at $218; Honduras 268 gross valued at $138; Canada, 143 gross valued at $180; and Paraguay, 95 gross valued at $23.

✦ ✦ ✦

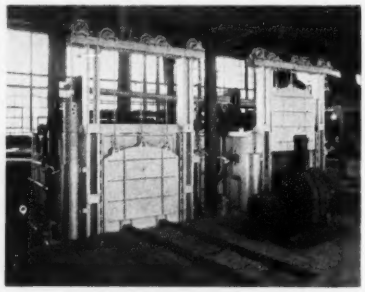
IMPORTS of wood screws during the same period were none.

✦ ✦ ✦

Underwriters' Laboratories Issue Standard for Rubber-Covered Wire

A FOURTH edition of its Standard for Rubber-Covered Wires and Cables has been issued by Underwriters' Laboratories. The outstanding feature of the new edition is the inclusion of requirements for four new types of rubber-insulated conductors—Types RW, RHT, RPT, and RU. The Laboratories are now accepting applications for the investigation of wires and cables of all of these types. Products which comply with the requirements of the standard will be listed specifically by the type-letter designation which applies and may be labeled as such, according to the Laboratories' announcement.

50 YEARS' EXPERIENCE IS BUILT INTO ROCKWELL INDUSTRIAL FURNACES



Fuel Fired Cradle Type Wire Annealing Furnaces.

Capacity from ounces to tons.
Continuous or batch process.
Bright or oxidized finish.
Full automatic or manual control.

Submit your heating problems to us. Write for catalog No. 9631.

W. S. ROCKWELL COMPANY
50 CHURCH STREET, NEW YORK

More Tonnage per Pound!

You can get a much higher tonnage of steel wire per pound of lubricant, insure longer die life and maintain better finish, with

MAGNUS WIRE DRAWING COMPOUNDS

Specially formulated to meet the definite conditions of wire size, type of drawing operations and other factors you face in your mill. There's a Magnus lubricant to suit your problems exactly on both wet and dry drawing operations.

GET THIS PERFORMANCE DATA

Ask for your set of reports covering performance of Magnus Wire Drawing Lubricants on all kinds and types of wire.

MAGNUS CHEMICAL CO.
188 South Ave., Garwood, N. J.
MAGNUS CLEANERS

WIRE DRAWING LUBRICANTS

FOR

BRIGHTER FINISH
GREATER SPEEDS
LONGER DIE LIFE
GREATER PRODUCTION
ECONOMY & SATISFACTION

Send for new Bulletin No. 102
"DRAWING OPERATIONS"
For Latest Developments

Fiske Brothers Refining Co.
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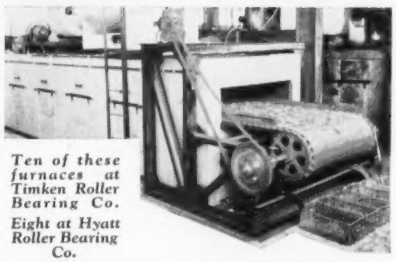
Newark, N. J.
Plants at
Newark, N. J. Toledo, Ohio

CARL-MAYER
AIR DRAW FURNACES for TEMPERING, ANNEALING



Ten of these furnaces at Timken Roller Bearing Co.
Eight at Hyatt Roller Bearing Co.

UP TO 70% SAVINGS + TEMPERATURE UNIFORMITY
2½° PLUS OR MINUS

MANY REPEAT ORDERS have been received from leading users of air draw furnaces, because of the above and following advantages:

- Use of air heater principle up to 1300°F.
- Fast heating cycle—20 minutes upward.
- Capacity—500 to 2000 pounds per hour.
- Heats large or small items with equal facility.

IDEAL FOR SPRINGS, BOLTS, WASHERS and Similar Products.

Write for Literature.

Over 20 Years' Experience
The CARL-MAYER Corp.
3030 Euclid Ave., CLEVELAND, OHIO.

Reactive Wire Drawing

(*Continued from Page 538*)

actively, at a higher rate of production and at lower cost.

✦ ✦ ✦

THE following explanation of terms and methods of calculating quantities, used in Reactive Drawing, may be found useful:

Reactive Load: By the term Reactive Load is meant the pull existing in the wire on the entering side of the die. This is designated as B in the equations.

Die Pressure: By the term Die Pressure is meant the force exerted in the cone of the die expressed as pull on the wire. This is designated as E in the equations.

Total Pull: By the term Total Pull is meant the pull existing in the wire between the die and the drawing block. This is designated as H in the equations.

Pull Ratio: By the term Pull Ratio is meant the ratio, expressed as percent, of the Reactive Load to the Total Pull. This is designated as K in the equations.

S = r.p.m. of drawing block shaft
P = r.p.m. of drawing block
R = radius of drawing block
W = torque in inch pounds on drawing block shaft.
%r = percent reduction
HP = horse power
H = E + B

(13) P = 2S (1 — %r) / (2 — %r)

(14) W = RH/4 + RB/2K

The quantities R/2 and R/4 are constants for any particular machine.

HP = WS/63025

For the derivation of equations (13) and (14) see the article on "The Saving in Power Achieved by Reacting Drawing" in WIRE AND WIRE PRODUCTS, May 1940.

✦ ✦ ✦

ALL wire was drawn and coiled on a 9" diameter pull block using Firthaloy Dies supplied for these experiments by the Firth-Sterling Steel Company, and soap compound lubricants supplied by the Standard Industrial Compounds Company.

This is an invitation for you to become a member of The Wire Association. ✦ ✦ ✦ ✦ ✦ ✦

The Annual Dues are $10.00

✦ ✦ ✦

For Details Address

Richard E. Brown, Secretary
The Wire Association
300 Main St., Stamford, Conn.
Tel: Stamford 3-0482

INCREASE LIFE OF YOUR DIES with *NEW* NOPCO SOAPS!

FOLLOW the lead of many of the country's largest steel wire mills. Increase the life of your dies by using Nopco "99" improved dry soaps.

In addition to longer life, you will find these 99% active dry soaps eliminate periodic die trouble formerly caused by faulty lubrication . . . result in a better wire finish . . . and give higher yields per pound of soap.

Nopco "99" soaps are available in three types—PX, LX and NX—for both high and low carbon wire and rod.

JUST ONE TRIAL WILL CONVINCE YOU!
Write Today!

NOPCO
BOSTON CHICAGO
CEDARTOWN, GA. LOS ANGELES
NATIONAL OIL PRODUCTS CO.
HARRISON, NEW JERSEY

CARL-MAYER HI-SPEED ROD BAKERS
(TRADE MARK)

CUT TIME • CUT COST

Results with first installation bring second order for Carl-Mayer HI-SPEED Indirect Pit Type Rod Baker from prominent Steel Company of Canada. Check these production figures:

Baker Temperature, 500°F. Load Per Pin, 2100 lbs.

LOW CARBON .15 - .20	HI-CARBON .4 - .7
7 Minutes per pin	9 Minutes per pin
7 " " "	10 " " "
6 " " "	11 " " "
8 " " "	10 " " "
6 " " "	9 " " "

PLUS 50% FUEL REDUCTION

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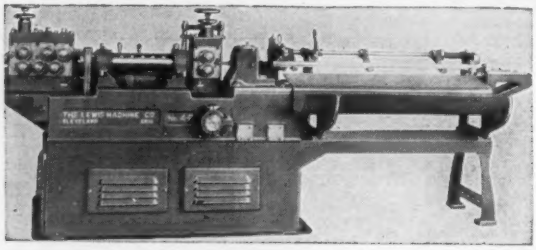

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Design and Operation of a New Copper Wire Drawing Plant

(*Continued from Page 558*)

ies. Further improvement is expected with the acquisition of additional data.

✦ ✦ ✦

Conclusion

THE use of high-speed machines have many distinct advantages. Fewer machine units facilitate the training of operators and the build-up of production. The condensed layout has simplified material handling. Adequate controls and records together with a well established maintenance routine is making possible excellent quality and better than anticipated costs.

✦ ✦ ✦

IN setting up and operating this project at Kearny, the engineering group responsible was greatly assisted by the Wire Mill experience and developments at the Hawthorne and Point Breeze Works and by the recommendations and designs of the material handling and factory planning engineers at Kearny. This cooperation, together with that obtained from the men on the machines and the maintenance groups, have been reflected in the results.

✦ ✦ ✦

The Great Reliance for National Defense

"NATIONAL defense rests strongly upon ability of the machinery-producing industries to equip our labor supply to out-produce any possible combination of nations to which we might be opposed," state **Farrel-Birmingham Company, Inc.**, Ansonia, Conn., in their recently published study, "The Great Reliance for National Defense." Data in the publication shows the relative man-power and man-hour resources of the United States as compared to Germany and Italy combined.

✦ ✦ ✦

"IN terms of labor supply our country has presently available some fifty-five million persons, of which about forty-five million are employed. These figures compare with the combined total labor supply of Germany and Italy of fifty-six million persons. With the labor supply of Austria, Czechoslovakia and Poland added the Axis powers have available eighty to eighty-five million workers; with France and Belgium included, the total becomes upward of 110 million persons."

"UNLESS our **per capita** productivity is enormously greater, even fifty-six million workers of the Axis powers employed at fifty to sixty hours per week as compared to our forty-five million workers at shorter hours represents an overwhelming advantage. In terms of man-hours per week, the Axis powers can concentrate some 2.75 billion man-hours as compared to some 1.80 billion man-hours in the United States.

✦ ✦ ✦

"THE only factor which compensates for our relative inferiority in man-hours is the tremendous productivity per man-hour of our highly mechanized industries. Figures currently available show the installed horsepower of our industrial equipment to be twice the **per capita** figures of Germany and Italy. Thus, the mechanization of America, despite the handicaps of the past decade, is the only factor which serves partially to compensate for our inferiority in labor supply and total man-hours. Compared with 1914, when we used approximately three horsepower per worker in manufacturing industry, we today command something over five horsepower per worker. It is not too much to say that our machinery-producing industries, in their highly developed state, could expand at twice the rate of 1914 the equipment needed for the munitions-producing industries.

✦ ✦ ✦

"AT the present time the machinery-producing industries, as distinguished from the machinery-using industries who will be called upon to manufacture military and naval equipment, have a trained personnel greater by some 400,000 workers than those available in 1914. Without underestimating the seriousness of the problem ahead, it is proper to state that the machinery-producing industries, through their progress since 1914-1918, have become **'The Great Reliance for National Defense'.**"

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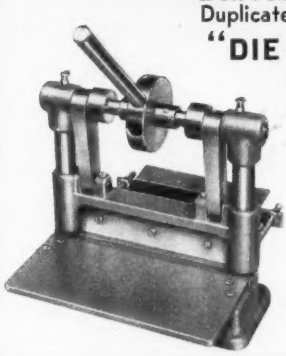

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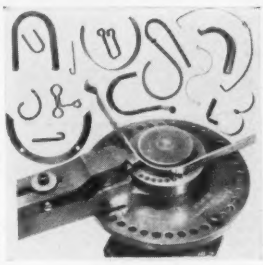

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Unusual Wrapping Problem Solved

SPECIAL wrapping problems for different sizes of wire coils that arrive at the Shipping Department presented an unusual problem at the new wire mill of the Wickwire Spencer Steel Company Plant at Buffalo.

✦ ✦ ✦

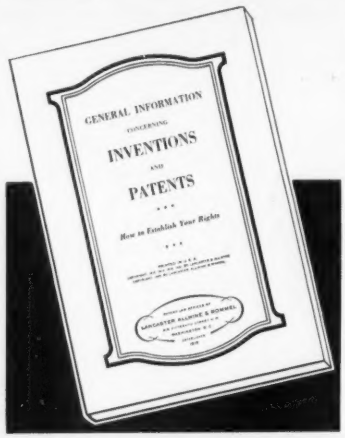
WHILE the Shipping Department had machinery of many different types for smaller and medium size coil wrappings it became necessary to have a machine that would handle the largest possible range of sizes and that could be changed quickly to paper wrap all of the larger type coils. At the suggestion of Mr. George Nelson, Superintendent at the Plant, the **Terkelsen Machine Company** of Boston, Massachusetts was called in to design a special machine for the work, which is described herewith.

✦ ✦ ✦

THIS wrapping machine differs from the regular line of wrapping machines because of the fact that it will accommodate a coil having a cross-section as large as 14″—an outside diameter as large as 60″—an inside diameter as small as 12″.

✦ ✦ ✦

THE yoke and shuttle assembly moves both up and down on tie rods and operation is by small motor. The feed rolls of the machine also move straight up and down and also by motor operation.



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IF a small coil is being wrapped, this can be done at waist-line level of the operator. On a large coil the feed rolls are lowered so that the coil is rolled into the machine, wrapped, and then rolled through the machine to a waiting freight car. So that in wrapping a rush order of heavy coils the wrapping operation is continuous, one man feeding, one man wrapping and another taking away.

✦ ✦ ✦

THE feed rolls of the machine are linked through a special variable speed feed device so that the feed of the coil may be varied at will. On LCL shipments the operator will move the lever so that a 75% overlap of the paper on the coil will be obtained. On CL the lever may be moved so that a 35% overlap may be used. Paper is applied as desired to the different grades of wire wrapped.

✦ ✦ ✦

WHILE the shuttle is of 30" diameter with a full 15" open gap, the speed of the wrapping is the same as the regular machine because of ball-bearing construction throughout and the use of a three horse power motor, the speed of the shuttle has been increased so that the wrapping time of the machine will run about a foot a second.

✦ ✦ ✦

WITH this machine the Wickwire Spencer Steel Company uses Rinkle Krinkle Paper with a patented fold edge and with a result that the largest coils withstand the ravages of the most difficult transportation.

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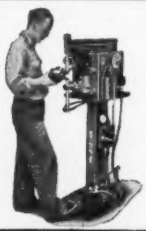
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Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Works, New York, N. Y.
Willey's Carbide Tool Co., Detroit, Mich.

DIRECT ELECTRIC RESISTANCE HEAT TREATING—
Trauwood Engineering Co., Cleveland, Ohio.

DRAW BENCHES—
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Foundry & Mach. Co., Trenton, N. J.
Standard Machinery Co., Providence, R. I.
Vaughn Machinery Co., Cuyahoga Falls, O.

DRUMS—Flange Steel
Stevens Metal Products Co., Niles, Ohio.

DRUMS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.

ENGINEERS—Consulting Wire Mill
Hartley, George D., Worcester, Mass.
Lewis, Kenneth B., Worcester, Mass.

EQIUPMENT—Insulation Testing
Davis, R. L., Electric Co., Wallingford, Conn.
Entwistle, James L., Pawtucket, R. I.

EYELETS—Brass or Zinc
Platt Bros. & Co., The, Waterbury, Conn.

FILLERS—Paper for Cable
Twitchell, E. W., Inc., Phila., Pa.

FLASH BAKER—
Carl-Mayer Corp., The, Cleveland, Ohio.

FURNACES—Annealing
Ajax Electric Co., Philadelphia, Pa.
Bellis Heat Treating Co., Branford, Conn.
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Lee Wilson Engineering Co., Cleveland, O.
Rockwell, W. S., Co., New York, N. Y.
Surface Combustion Corp., Toledo, Ohio
Trauwood Engineering Co., Cleveland, Ohio.

FURNACES—Automatic
Bellis Heat Treating Co., Branford, Conn.
Carl-Mayer Corp., Cleveland, Ohio
Electric Furnace Co., Salem, Ohio.
Lee Wilson Engineering Co., Cleveland, O.
Surface Combustion Corp., Toledo, Ohio

FURNACES—Brazing
Electric Furnace Co., Salem, Ohio.
Firth-Sterling Steel Co., McKeesport, Pa.

FURNACES—Bright Annealing
Bellis Heat Treating Co., Branford, Conn.
Electric Furnace Co., Salem, Ohio.
Lee Wilson Engineering Co., Cleveland, O.
Rockwell, W. S., Co., New York, N. Y.
Surface Combustion Corp., Toledo, Ohio

FURNACES—Electric
Ajax Electric Co., Philadelphia, Pa.
Bellis Heat Treating Co., Branford, Conn.
Electric Furnace Co., Salem, Ohio.
Rockwell, W. S., Co., New York, N. Y.
Surface Combustion Corp., Toledo, Ohio
Trauwood Engineering Co., Cleveland, Ohio.

FURNACES—Hardening & Tempering
Ajax Electric Co., Philadelphia, Pa.
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corp., Toledo, Ohio
Trauwood Engineering Co., Cleveland, Ohio.

FURNACES—Lead Melting
Electric Furnace Co., Salem, Ohio.
Robertson, John, Co., Brooklyn, N. Y.
Rockwell, W. S., Co., New York, N. Y.
Surface Combustion Corp., Toledo, Ohio

FURNACES—Non-Oxidizing
Ajax Electric Co., Philadelphia, Pa.
Bellis Heat Treating Co., Branford, Conn.
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Rockwell, W. S., Co., New York, N. Y.
Surface Combustion Corp., Toledo, Ohio

FURNACES—Normalizing
Ajax Electric Co., Philadelphia, Pa.
Carl-Mayer Corp., Cleveland, Ohio
Electric Furnace Co., Salem, Ohio.
Rockwell, W. S., Co., New York, N. Y.
Surface Combustion Corp., Toledo, Ohio

FURNACES—Salt Bath
Ajax Electric Co., Philadelphia, Pa.
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corp., Toledo, Ohio

FURNACES—Wire, Strip & Sheet
Bellis Heat Treating Co., Branford, Conn.
Carl-Mayer Corp., The, Cleveland, Ohio
Electric Furnace Co., Salem, Ohio.
Lee Wilson Engineering Co., Cleveland, O.
Rockwell, W. S., Co., New York, N. Y.
Surface Combustion Corp., Toledo, Ohio

GALVANIZING EQUIPMENT—
Lee Wilson Engineering Co., Cleveland, O.
Meaker Co., The, Chicago, Ill.

GEARS—Wire Mill
Farrel-Birmingham Co., Ansonia, Conn.

GRINDERS—Roll
Farrel-Birmingham Co., Ansonia, Conn.
Norton Co., Worcester, Mass.

HI-SPEED BAKERS—
Carl-Mayer Corp., The, Cleveland, Ohio

HOISTS—Electric Travelling
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.

INHIBITORS—
American Chemical Paint Co., Ambler, Pa.
National Oil Products Co., Harrison, N. J.
Parkin, Wm., Co., The, Pittsburgh, Pa.

WHERE TO BUY, Continued

INSTRUMENTS—Electrical
Entwistle, James L., Pawtucket, R. I.

INSULATION—Cable or Cable Filler
Twitchell, E. W., Inc., Philadelphia, Pa.

LATHES—Die Reaming
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

LIME—
Warner Company, The, Bellefonte, Pa.

LUBRICANTS—For Metal Cutting, Stamping and Drawing
Fiske Bros. Refining Co., Newark, N. J.
Magnus Chemical Co., Garwood, N. J.
National Oil Products Co., Harrison, N. J.

LUBRICANTS—Wire Drawing
Fiske Bros. Refining Co., Newark, N. J.
Magnus Chemical Co., Garwood, N. J.
National Oil Products Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

MACHINERY—Armoring (Cable, Wire Hose)
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Robertson, John, Co., Brooklyn, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Braiding
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Brazing
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.

MACHINERY—Bunching
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Bundling, Scrap
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cable, Electric
American Insulating Mach'y. Co., Phila., Pa.
Entwistle, James L., Pawtucket, R. I.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Chain Making
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Closing
New England Butt Co., Providence, R. I.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Coil Winding
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Coilers
Broden Construction Co., Cleveland, Ohio
Entwistle, James L., Pawtucket, R. I.
Farrel-Birmingham Co., Ansonia, Conn.
Morgan Construction Co., Worcester, Mass.
New England Butt Co., Providence, R. I.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cold Heading
National Machinery Co., Tiffin, Ohio.

MACHINERY—Cold Heading with Wire Drawing Attachment
Ajax Manufacturing Co., Cleveland, O.

MACHINERY—Copper Wire Drawing and Rolling
Farrel-Birmingham Co., Ansonia, Conn.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Covering Wire
Fidelity Machine Co., Philadelphia, Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Cutting
Broden Construction Co., Cleveland, Ohio
Farrel-Birmingham Co., Ansonia, Conn.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, Ohio.
Moslo Machinery, Inc., Cleveland, Ohio
National Machinery Exchange (Used), New York, N. Y.
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Shuster, F. B., Co., New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Die Making
Firth-Sterling Steel Co., McKeesport, Pa.

MACHINERY—Die Making—for Special Shapes and Forms
O'Neil-Irwin Mfg. Co., Minneapolis, Minn.

MACHINERY—Draw Benches
Standard Machinery Co., Providence, R. I.

MACHINERY—Edging
Standard Machinery Co., Providence, R. I.

MACHINERY—Enameling
American Insulating Mach'y. Co., Phila., Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Extruding
Robertson, John, Co., Brooklyn, N. Y.
Royle, John & Sons, Paterson, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Flat Wire
Broden Construction Co., Cleveland, Ohio
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Forming
National Machinery Exchange (Used), New York, N. Y.
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Galvanizing
Lee Wilson Engineering Co., Cleveland, O.

MACHINERY—Galvanizing Wire
Broden Construction Co., Cleveland, Ohio
Lee Wilson Engineering Co., Cleveland, O.
Meaker Co., The, Chicago, Ill.
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Gang Winders
Fidelity Machine Co., Philadelphia, Pa.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Grinding
Norton Co., The, Worcester, Mass.

MACHINERY—Insulating
American Insulating Mach'y Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Knitting
Fidelity Machine Co., Philadelphia, Pa.

MACHINERY—Lead Encasing Presses, etc.
Robertson, John, Co., Brooklyn, N. Y.

MACHINERY—Lead Stripping
Robertson, John, Co., Brooklyn, N. Y.
Watson Machine Co., Paterson, N. J.

MACHINERY—Lock Washer
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Magnet Wire
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Material Handling
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.

MACHINERY—Measuring Wire & Cable
Davis, R. L., Electric Co., Wallingford, Conn.
Durant Mfg. Co., Milwaukee, Wisc.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Nail and Tack
Glader, Wm., Machine Works, Chicago, Ill.
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Panning
American Insulating Mach'y Co., Phila., Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Paper Covering Wire
Terkelsen Machine Co., Boston, Mass.

MACHINERY—Pointing
Broden Construction Co., Cleveland, Ohio
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Mach. Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Rod Mill
Broden Construction Co., Cleveland, Ohio
Farrel-Birmingham Co., Ansonia, Conn.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.

MACHINERY—Rolling Mill
Broden Construction Co., Cleveland, Ohio
Farrel-Birmingham Co., Ansonia, Conn.
Morgan Construction Co., Worcester, Mass.
National Machinery Exchange (Used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Rubber for Insulating Wire
Farrel-Birmingham Co., Ansonia, Conn.
National Rubber Machinery Co., Akron, O.
Royle, John & Sons, Paterson, N. J.

MACHINERY—Rubber Strip Covering
Farrel-Birmingham Co., Ansonia, Conn.
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Rubber Tubing and Straining
Farrel-Birmingham Co., Ansonia, Conn.
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Screw Wire
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Special
American Insulating Mach'y Co., Phila., Pa.
Broden Construction Co., Cleveland, Ohio
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I. (Special Designs)
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Spooling
American Insulating Mach'y Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Spring Making
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

WHERE TO BUY, Continued

MACHINERY—Staple
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Straightening
Broden Construction Co., Cleveland, Ohio
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, O.
Moslo Machinery, Inc., Cleveland, Ohio
National Machinery Exchange (Used), New York, N. Y.
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Ruesch, H. J., Machine Co., Newark, N. J.
Shuster, F. B., Company, New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Stranding
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Strip Steel
Broden Construction Co., Cleveland, Ohio
Ruesch, H. J., Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Swaging
National Machinery Exchange (Used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Taping
American Insulating Mach'y Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Testing
Entwistle, James L., Pawtucket, R. I.
Scott, Henry L., Co., Providence, R. I.

MACHINERY—Testing Size of Wire
Davis, R. L., Electric Co., Wallingford, Conn.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Testing, Spring
Standard Machinery Co., Providence, R. I.

MACHINERY—Tinsel Rolling Mills
American Insulating Mach'y Co., Phila., Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Trolley Wire
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Tube Mill
Ruesch, H. J., Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Welding Wire
Eisler Engineering Co., Newark, N. J.
Igoe Bros., Inc., Newark, N. J.
Micro Products Co., Chicago, Ill.
Shuster, F. B., Co., New Haven, Conn.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.

MACHINERY—Winding
American Insulating Mach'y Co., Phila., Pa.
Entwistle, James L., Pawtucket, R. I.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Drawing
American Insulating Mach'y Co., Phila., Pa.
Broden Construction Co., Cleveland, Ohio
Morgan Construction Co., Worcester, Mass.
National Machinery Exchange (Used), New York, N. Y.
Reactive Wire Drawing, Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Wire Measuring
Durant Mfg. Co., Milwaukee, Wisc.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Rope
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Tinning
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Wood Screw
National Machinery Exchange (Used), New York, N. Y.

MACHINERY—Wrapping Wire
Terkelsen Machine Co., Boston, Mass.

MATERIAL HANDLING EQUIPMENT—
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.

MILLS—Tandem Rolling and Edging
Standard Machinery Co., Providence, R. I.
Torrington Mfg. Co., The, Torrington, Conn.

NICKEL SILVER AND PHOSPHOR BRONZE—Rod, Wire and Strip
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

OILS—Wire Drawing
National Oil Products Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

OVENS—Industrial
Carl-Mayer Corp., The, Cleveland, Ohio
Ross, J. O., Engineering Corp., New York, N. Y.

PANS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.

PAPER—Creped Wrapping
Crepe-Kraft Co., Inc., Newark, N. J.

PAPER—Insulating
Twitchell, E. W., Inc., Phila., Pa.

PAPER TESTERS—
Scott, Henry L., Co., Providence, R. I.

PATENT ATTORNEYS—
Lancaster, Allwine and Rommel, Washington, D. C.

PICKLING COMPOUNDS—
American Chemical Paint Co., Ambler, Pa.
National Oil Products Co., Harrison, N. J.
Parkin, Wm., Co., The, Pittsburgh, Pa.

PLASTIC TESTERS—
Scott, Henry L., Co., Providence, R. I.

POTS—Lead Melting
Farrel-Birmingham Co., Ansonia, Conn.
Robertson, John, Co., Brooklyn, N. Y.

PRESSES—Hydraulic and Mechanical
Farrel-Birmingham Co., Ansonia, Conn.
Robertson, John, Co., Brooklyn, N. Y.
Standard Machinery Co., Providence, R. I. (Mechanical Only)

PRESSES—Lead
Robertson, John, Co., Brooklyn, N. Y.

PULLERS—Wire
Scudder, E. J., Foundry & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.

PUMPS—Hydraulic
Robertson, John, Co., Brooklyn, N. Y.

REACTIVE WIRE DRAWING—
Reactive Wire Drawing, Worcester, Mass.

RECORDERS—Fault and Reel
Entwistle, James L., Pawtucket, R. I.

REEL AND TENSION STAND—
Fidelity Machine Co., Philadelphia, Pa.
Moslo Machinery, Inc., Cleveland, Ohio
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

REEL CRUTCHES—
Watson Machine Co., Paterson, N. J.

REELS—Annealing and Stranding
American Pulley Co., Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Moslo Machinery, Inc., Cleveland, Ohio
Mossberg Pressed Steel Corp., Attleboro, Mass.
Shuster, F. B., Co., New Haven, Conn.
Stevens Metal Products Co., Niles, O.

REELS—Steel
American Pulley Co., Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REELS AND SPOOLS—Shipping and Shop
American Pulley Co., Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REELS—Takeoff
American Pulley Co., Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Moslo Machinery, Inc., Cleveland, Ohio
Mossberg Pressed Steel Corp., Attleboro, Mass.
Shuster, F. B., Co., New Haven, Conn.
Stevens Metal Products Co., Niles, O.

REELS—Vulcanizing and Impregnating
Apco Mossberg Co., Attleboro, Mass.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Shuster, F. B., Co., New Haven, Conn.
Stevens Metal Products Co., Niles, O.

REELS—Wire Drawing
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Moslo Machinery, Inc., Cleveland, O.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REFRACTORIES—High Temperature
Norton Co., Worcester, Mass.

ROD BAKERS—
Carl-Mayer Corp., The, Cleveland, Ohio
Moslo Machinery, Inc., Cleveland, O.
Ross, J. O., Engineering Corp., New York, N. Y.

RODS—Wire—Non-Ferrous
American Brass Co., Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.
Platt Bros. & Co., The, Waterbury, Conn.
Seymour Mfg. Co., Seymour, Conn.

RODS—Wire—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Sheffield Steel Corp., Kansas City, Mo.
Wheeling Steel Corp., Wheeling, W. Va.

ROLLS—
Farrel-Birmingham Co., Ansonia, Conn.

ROLL STRAIGHTENERS—
Moslo Machinery, Inc., Cleveland, O.

RUBBER AND RUBBER COMPRESSION TESTERS—
Scott, Henry L., Co., Providence, R. I.

RUST PROOF COMPOUNDS—
American Lanolin Co., Lawrence, Mass.

SHEET—Steel
Continental Steel Corp., Kokomo, Ind.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Wheeling Steel Corp., Wheeling, W. Va.

SKIN PROTECTOR—
Magnus Chemical Co., Garwood, N. J.

SOAPS—Industrial and Wire Drawing
Magnus Chemical Co., Garwood, N. J.
National Oil Products Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

SPARK TESTING EQUIPMENT—
Entwistle, James L., Pawtucket, R. I.

SPOOLS—Annealing and Wire Drawing
American Pulley Co., Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

WHERE TO BUY, Continued

SPOOLS—Shipping and Shop
American Pulley Co., Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp, Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

SPOOLS—Steel
American Pulley Co., Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

STAMPINGS—Steel
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

STRIP—Brass and Non-Ferrous
American Brass Co., Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

STRIP—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Firth-Sterling Steel Co., McKeesport, Pa.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.

STRIP METAL TESTERS—
Scott, Henry L., Co., Providence, R. I.

SWIFTS—Take-off
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.

TAKE-UPS FOR CABLE, HOSE, LEAD PRESSES AND SHEET RUBBER
Entwistle, James L., Pawtucket, R. I.

TANKS—Acid
Hauser-Stander Tank Co., Cincinnati, Ohio.

TANKS—Compounds
Watson Machine Co., Paterson, N. J.

TANKS—Lead Lined
Hauser-Stander Tank Co., Cincinnati, Ohio.

TANKS—Pickling
Hauser-Stander Tank Co., Cincinnati, Ohio.

TANKS—Rubber Lined
Hauser-Stander Tank Co., Cincinnati, Ohio.

TANKS—Steel
Mossberg Pressed Steel Corp., Attleboro, Mass.

TANKS—Wooden
Hauser-Stander Tank Co., Cincinnati, Ohio.

TENSILE TESTERS—
Scott, Henry L., Co., Providence, R. I.

TESTING INSTRUMENTS—
Entwistle, James L., Pawtucket, R. I.
Scott, Henry L., Co., Providence, R. I.

TRAMRAIL SYSTEMS—
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.

TREADS—Safety
Norton Co., Worcester, Mass.

TRUCKS—
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

TUBE BENDERS AND FORMERS—
Ruesch, H. J., Machine Co., Newark, N. J.

TURKS HEAD—Friction and Power Driven
Standard Machinery Co., Providence, R. I.

VULCANIZERS—
Watson Machine Co., Paterson, N. J.

VULCANIZING PANS—
American Insulating Mach'y Co., Phila., Pa.
Mossberg Pressed Steel Corp., Attleboro, Mass.

WELDERS—Spot and Butt
Eisler Engineering Co., Newark, N. J.
Igoe Bros., Inc., Newark, N. J.
Micro Products Co., Chicago, Ill.
Moslo Machinery, Inc., Cleveland, O.

WIRE—Cold Heading
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Sheffield Steel Corp., Kansas City, Mo.
Wheeling Steel Corp., Wheeling, W. Va.

WIRE DRAWING—High Grade Custom
Hy-Carbo Steel Co., Lowell, Mass.

WIRE—Electric
American Brass Co., Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

WIRE—Enameled for Coils
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE-MANUFACTURERS—
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Firth-Sterling Steel Co., McKeesport, Pa.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Sheffield Steel Corp., Kansas City, Mo.
Wheeling Steel Corp., Wheeling, W. Va.
Wickwire Bros., Inc., Cortland, N. Y.

WIRE—Nickel Silver and Phosphor Bronze
American Brass Co., Waterbury, Conn.
Callite Tungsten Corp., Union City, N. J.
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

WIRE—Non-Ferrous to Specification for Special Purposes
American Brass Co., Waterbury, Conn.
Callite Tungsten Corp., Union City, N. J.
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE-SPRING—
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Firth-Sterling Steel Co., McKeesport, Pa.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Seymour Mfg. Co., Seymour, Conn.
Sheffield Steel Corp., Kansas City, Mo.

WIRE—Stainless Steel
Callite Tungsten Corp., Union City, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.

WIRE—Steel—Also Coppered Steel—Also Galvanized Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Sheffield Steel Corp., Kansas City, Mo.
Wheeling Steel Corp., Wheeling, W. Va.
Wickwire Bros., Inc., Cortland, N. Y.

WIRE AND STRIP—Zinc
Platt Bros. & Co., The, Waterbury, Conn.

WIRE TESTERS—
Scott, Henry L., Co., Providence, R. I.

WIRE, WEAVING—Non-Ferrous
American Brass Co., Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.

WRAPPING PAPER—Creped
Crepe-Kraft Co., Inc., Newark, N. J.

YARN TESTERS—
Scott, Henry L., Co., Providence, R. I.

Statement of Ownership

Statement of ownership, management, circulation, etc., required by the Act of Congress of August 24, 1912 and March 3, 1933, of Wire & Wire Products published monthly at Washington, N J., for October 1, 1940.

State of Connecticut, County of Fairfield, ss.: Before me, a Notary Public in and for the State and county aforesaid, personally appeared Richard E. Brown, who, having been duly sworn according to law, deposes and says that he is the President of Wire & Wire Products and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Quinn-Brown Publishing Corporation, 300 Main St., Stamford, Conn.; editor, Richard E. Brown, 300 Main St., Stamford, Conn.; managing editor, none; business manager, R. S. Spengel, 300 Main St., Stamford, Conn.

2. That the owner is: (if owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) Quinn-Brown Publishing Corporation, 300 Main St., Stamford, Conn.; Leta B. Brown, of 300 Main St., Stamford, Conn. and Richard E. Brown, 300 Main St., Stamford, Conn.

3. That the known bondholders, mortgagees, and other security holders owning or holding one per cent of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

RICHARD E. BROWN
(President)

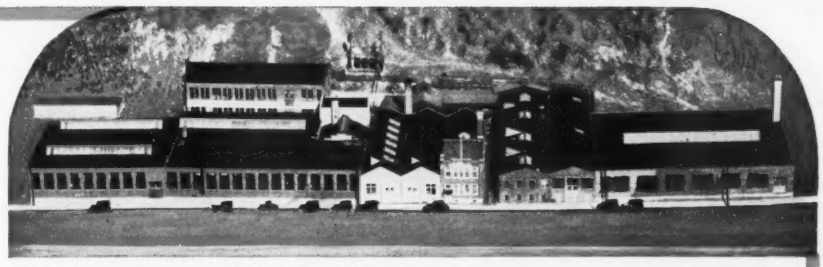
Sworn to and subscribed before me this 23rd day of September, 1940.

(SEAL) WILLIAM A. MURPHY,
Notary Public.

HUDCO

SPECIALIZES

WINCO



HUDSON WIRE CO. PLANT AT OSSINING, N. Y.

HUDCO AT OSSINING PRODUCES FINE WIRES IN ALL METALS.

FINE BARE WIRES

High Brass, Low Brass, Zinc 99.99+ and High Tensile Zinc, Commercial Bronze, Phosphor Bronze, Pure Tin, Lead, Antimonial Lead, Tinsel Lahns, Silver Plated Copper, False Gold and Copper.

Cadmium, Nickel Silver, 10%, 18%, and 30%; Silver Plated Copper, False Gold and Special Brass and Bronze Alloys to Specification, Metallic Fibre for Packing Purposes, Copper, Bronze, Zinc, Lead and Aluminum.

WIRES FOR METAL SPRAYING

Pure Lead, Lead Alloy, Pure Zinc, Zinc Alloy, Copper, Tin, High Brass, Low Brass, Solder Wire, High Conductivity, Electric Wire.

Cadmium, Nickel Silver, (10%, 18%, 30%); Aluminum, Monel Metal, Phosphor Bronze, Pure Nickel, Commercial Bronze.

"HUDCO" SPECIALLY PROCESSED COPPER WIRE FOR ENAMELLING PURPOSES IS DRAWN FROM SELECTED COPPER, INSURING THE MAXIMUM CONDUCTIVITY. THIS SELECTION PLUS OUR LONG EXPERIENCE AND UNEXCELLED PLANT FACILITIES INSURE OUR CUSTOMER BETTER WIRE AT LOWER COST.

WRITE TODAY FOR SAMPLES AND PRICES —

HUDSON WIRE COMPANY
OSSINING, N. Y.

ESTAB. 1902

SUCCESSORS - ROYLE AND AKIN

WINCO AT WINSTED, CONN. PRODUCES LEAKPROOF ENAMELLED WIRE AND OTHER WINCO ENAMELLED AND COVERED WIRES.

WRITE FOR SAMPLES AND PRICES —

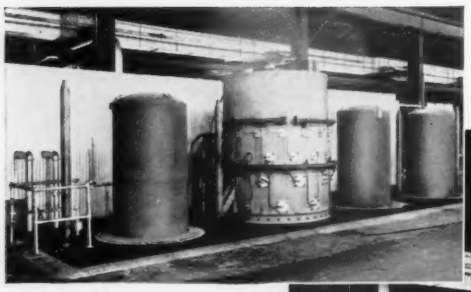
WINSTED DIVISION
HUDSON WIRE COMPANY
WINSTED CONNECTICUT

E. F. Gas Fired Bell Type Furnaces

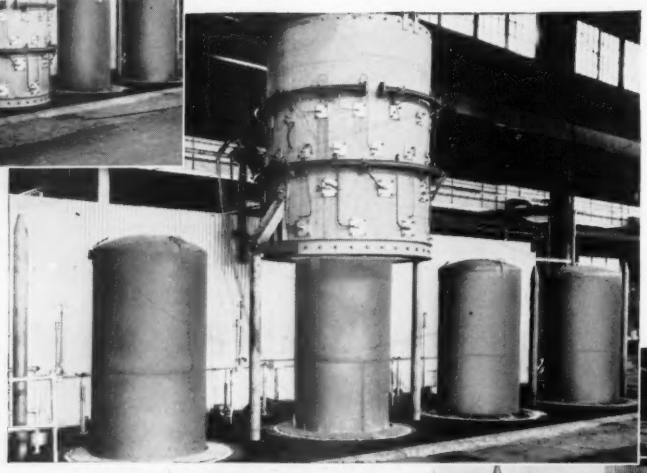
Maintain Uniform Temperature Throughout Charge

Regardless of the

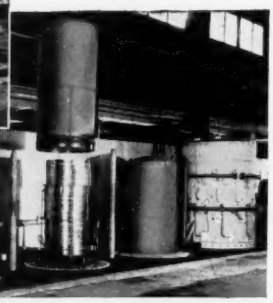
Weight, Size or Height of Load



(Above) An E. F. Bell Type Installation consisting of furnace, 4 bases, and retorts.



(Left) Each base accommodates charges up to 22,000 lbs. and coils up to 45" in diameter.



(Right) Removing a retort from base showing bright annealed charge.

ELECTRIC FURNACES FUEL FIRED

For Annealing Strip, Wire and Other Products

Equipped with special radiant type gas burners and separate automatic temperature control zones, these E. F. gas fired removable hood type furnaces obtain and maintain uniform temperature distribution throughout the entire charge on each and every load, regardless of weight, size or height of load.

The installation shown above was designed for annealing medium and high carbon mirror-finish cold rolled steel strip, and is equipped with special E. F. gas generator equipment for producing the protective atmosphere for bright annealing without decarburization. Each base accommodates charges up to 22,000 lbs. and handles coils in any width up and to 45" in diameter.

This installation is equipped with a pre-mix plant for mixing the gas and air in proper proportions. This eliminates all manual burner adjustments, as the gas-air mixture is previously obtained in the machine. The high turn down ratio on burners permits use of modulating type control.

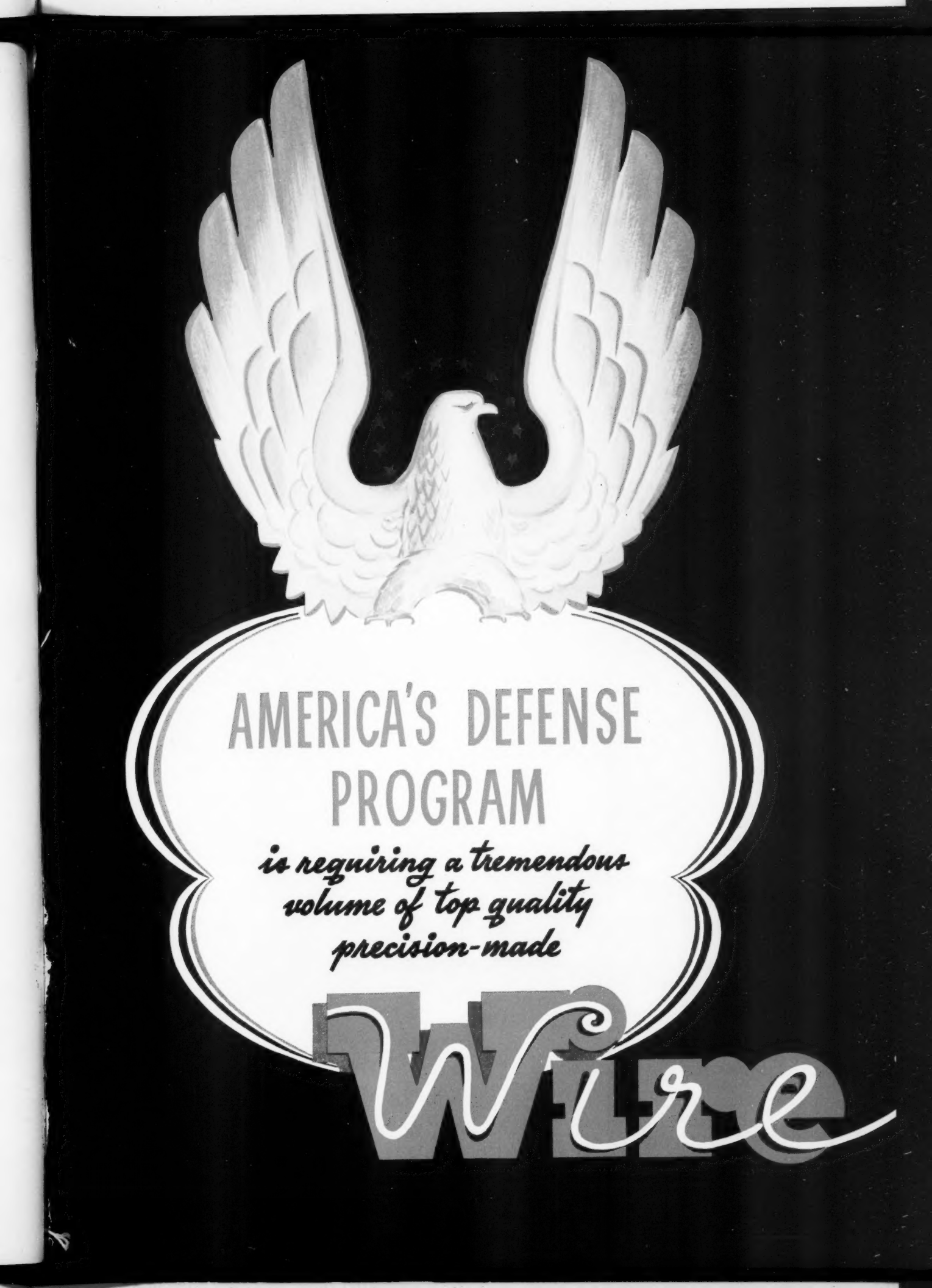
This equipment is provided with 4 bases, each with motor driven centrifugal type fan for circulating atmosphere down through the center of the charge and up between the outside of coil and the gas-tight retorts.

An extremely high rate of circulation is obtained and uniform temperature is provided and maintained regardless of the size of charge. Additional information on the above or on any other type furnace will be gladly furnished on request.

The above is only one of the numerous types we build for various annealing and heat treating purposes. We build Gas Fired, Oil Fired and Electric Furnaces—Furnaces for any process, product or production. Our large and experienced engineering staff and ample manufacturing facilities enable us to make reasonably prompt deliveries. We solicit your inquiries.

The Electric Furnace Co., Salem, Ohio

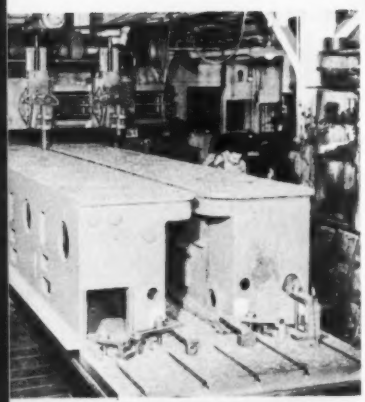
Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production


AMERICA'S DEFENSE PROGRAM
is requiring a tremendous volume of top quality precision-made
Wire

here's "Black and White" _proof_ that... PREC

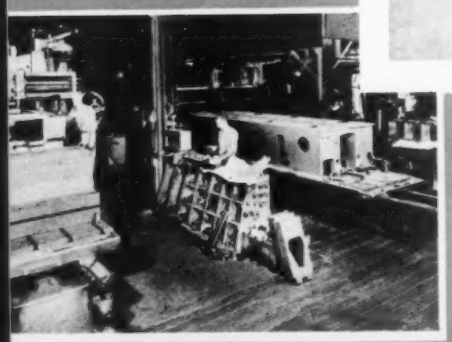
IN ALL VAUGHN

Worm and gear inspection.

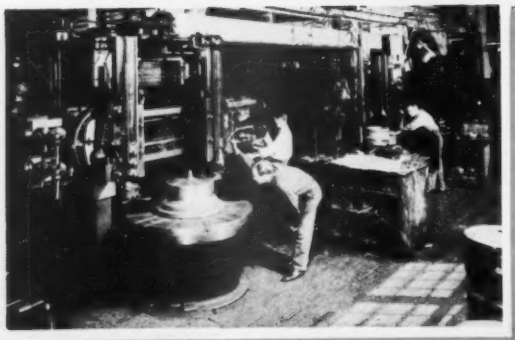


" x 20-ft. planer machining Motoblox housings.

Micrometer check on bearing housing.

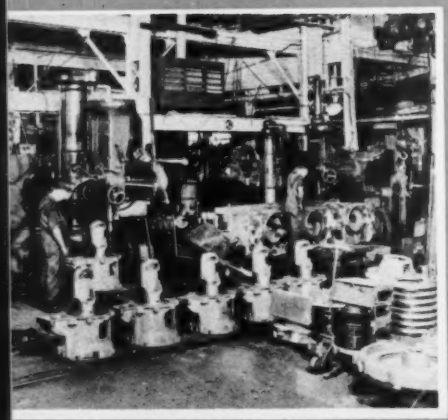


General view 72" and 84" planers.



Turning intermediate Motoblox drawing block.

Checking intermediate Motoblox drawing block.



Drill presses on various operations.

Layout crew, table and storage.

Boring mill operation.

ECISION IS "BUILT-IN"

HN WIRE DRAWING MACHINERY

★ **. . . THE KIND OF PRECISION THAT ASSURES YOU OF FAULTLESS, TOP-SPEED, HIGH QUALITY WIRE PRODUCTION**

No producer of wire can afford kinks and snarls in production volume during the months of great demand to come—not only for the sake of his own profitable operations, but for the benefit of our country's defense position as a whole.

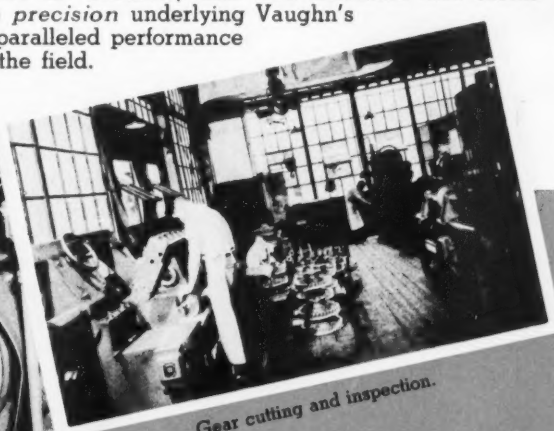
Rigid specifications, high-speed production, tight schedules; all will demand the utmost precision and reliability in wire drawing machinery—*the kind that is built into Vaughn Machinery from the ground up.*

These photographs, taken at random through the Vaughn plant, show a cross section of the many precise operations involved in Vaughn machinery construction. As the illustrations suggest, the greatest care is exercised in the machining process throughout the progression of construction. Progress inspections are relentlessly exact—each inspector must answer to the engineering department for the close tolerances required and set by the designers. In some instances, no machines existed which would provide the inspection required on some parts (notably parallel shaft and right angle gears)—until Vaughn built them. All parts subject to wear are manufactured on or with jigs, and are completely interchangeable.

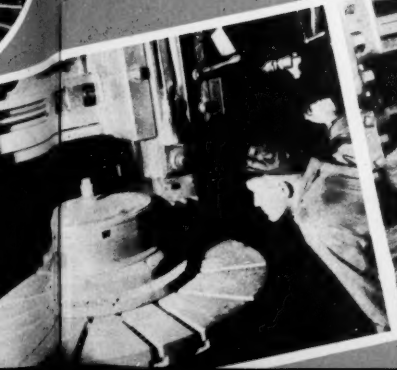
We extend an open invitation to any of our customers to visit our Plant and inspect at first hand its facilities —see the methods, men and machines that create the *precision* underlying Vaughn's unparalleled performance in the field.

Semi-automatic lathe—turning and boring.

Semi-automatic lathe—turning capstan.



Gear cutting and inspection.



Boring mill operation.

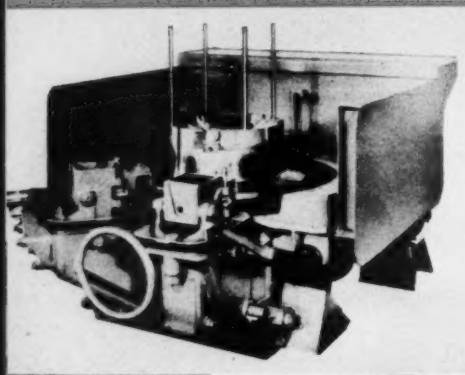
Small parts inspection.

General view semi-automatic department.

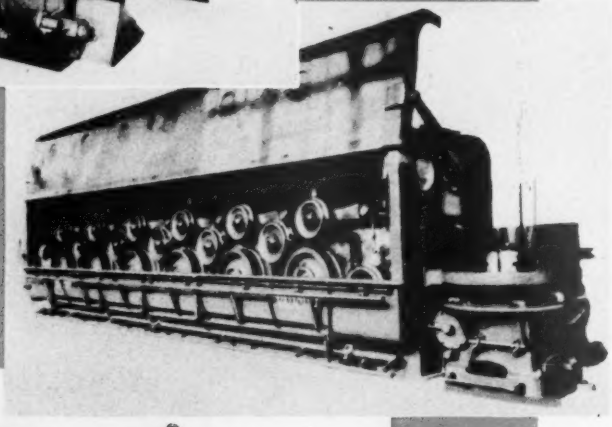
Vaughn builds

COMPLETE EQUIPMENT

for the modern wire mill



No. 13 D. D. air and water-cooled Motobloc.

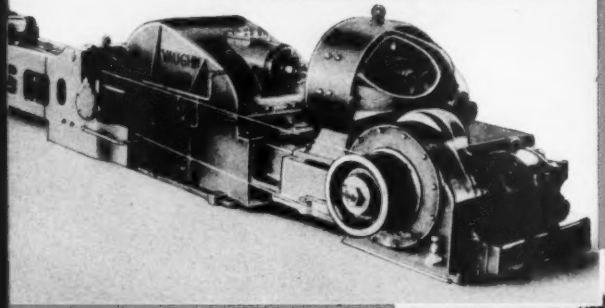


7-HRH Motoblox—copper and special alloys.

Below—50,000 lb. draw bench.

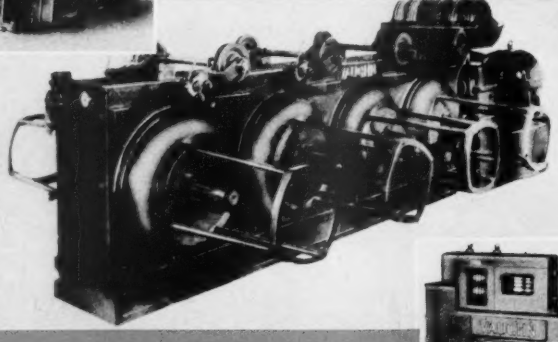
The photographs on this page illustrate the wide variety of equipment which we manufacture and make available for wire mills. There is a complete inter-lock on equipment for practically all metals except precious metals, including equipment for drawing bars, tubes, large-size rounds and shapes, take-up frames, continuous machines with controlled speed and also with minimum slip for copper, take-up frames for patenting and galvanizing, pointers, etc.

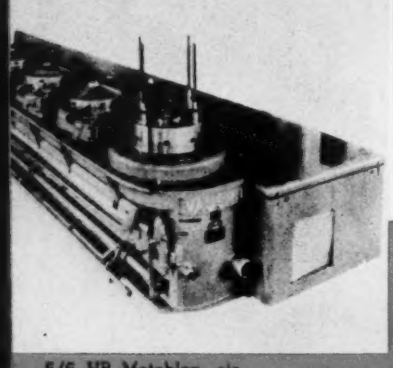
Whatever your requirements, whatever your products, you may be certain of top precision and dependability when you specify VAUGHN. Talk it over with a Vaughn Representative!



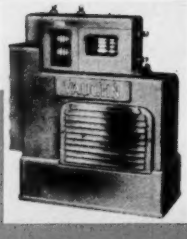
Below—Take-up frames.

Below—4-Cone Continuous Machine—copper, brass, bronze, etc.

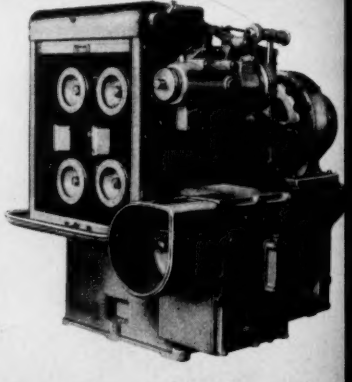




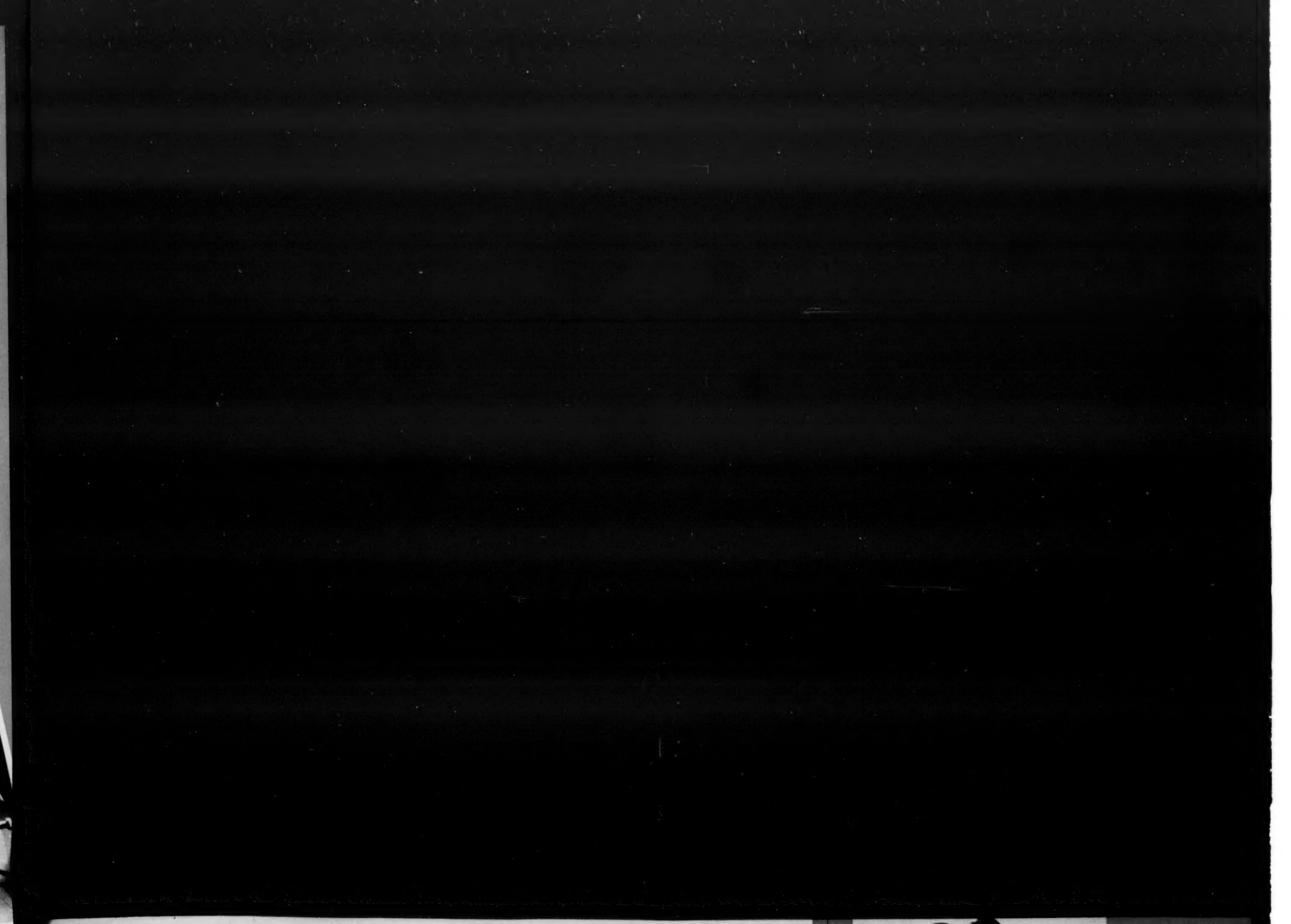
5/6-HR Motoblox, air and water-cooled.



4-Roll Pointer.



THE Vaughn MACHINERY COMPANY
CUYAHOGA FALLS, OHIO
U. S. A.

COMPLETE WIRE DRAWING EQUIPMENT . . . CONTINUOUS OR SINGLE HOLE . . . FOR THE LARGEST BARS . . . FOR THE SMALLEST WIRE . . . FERROUS, NON-FERROUS MATERIALS OR THEIR ALLOYS

LITHO in U. S. A.